INDIAN TEA ASSOCIATION

TOCKLAI EXPERIMENTAL STATION

Proceedings

OF THE

FIRST ANNUAL CONFERENCE.

Held at Tocklai on the 18th 19th and 20th February, 1937.

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JORHAT.

FIRST ANNUAL CONFERENCE.
1937
PROGRAMME.

Thursday

10.0 a. m. (a) Meeting of the Conference and Addresses by the Chief Scientific Officer, and Chairman of the I. T. A. Calcutta.

(b) A lecture on Organic Matter in Tea Soils by Mr. Cooper.

(c) A lecture on Black Rot Control by Mr. Tunstall.

2.0 p. m. "A" group visit Chemical and Botanical laboratories.
"B" group visit Mycological and Bacteriological laboratories.
"C" group visit Borbhetta.

Friday

10.0 a. m. (a) A lecture on Jats of Tea by Dr. Wight.

(b) A lecture on Bacterial Distribution by Mr. Benton.

(c) A lecture on Experiments on the Quality of Tea by Mr. Harrison.

2.0 p. m. "A" group visit Mycological and Bacteriological laboratories.
"B" group visit Borbhetta.
"C" group visit Chemical and Botanical laboratories.

Saturday

10.0 a. m. "A" group visit Borbhetta.
"B" group visit Chemical and Botanical laboratories.
"C" group visit Mycological and Bacteriological laboratories.

2.0 a. m. Conference.
Chief Scientific officer outlines Programme of Work for 1937.

Group "A" :— Messrs Nicholl, Boyle, Cullen, Fegan.
Group "B" :— Messrs Rainey, McLennan, Graham, Irving.
Group "C" :— Messrs Burton, Smart, Luard.

Proceedings of a meeting held on Thursday the 18th February 1937 at 10. 0 a. m at the Tocklai Experimental Station.

Present :—

Chairman.	Mr. P. H. Carpenter	Chief Scientific Officer
Delegates.	Mr. C. K. Nicholl	Chairman Indian Tea Assocn. Calcutta.
	Mr G. A Rainey	Indian Tea Association Member of Committee Calcutta.
	Mr. R. L. McLennan Mr. R. G. Boyle	Assam Branch Indian Tea Association South Bank.
	Mr. M. H. Burton	Assam Branch Indian Tea Association North Bank.
	Mr. J. W. Smart Mr W. Cullen	Surma Valley Branch I.T.A.
	Mr. F. M. Graham Mr. B E. Luard	Dooars Planters' Association.
	Mr K. I. M. Fegan	Darjeeling Planters' Association.
	Mr. M. Irving	Terai Planters' Association
	Mr. H. R. Cooper	First Chemist, Tocklai Exp. Stn.
	Mr. A. C. Tunstall	Mycologist, ,,
	Mr, C. J. Harrison	Second Chemist, ,,
	Mr. S. F Benton	Bacteriologist, ,,
	Dr W. Wight	Botanist, ,,

The Chairman, in opening the Conference, addressed the delegates as follows :—

My first duty is to welcome you to Tocklai.

This meeting is the initiation of a new experiment arising out of a recommendation of the Engledow Commission. The reason for this Conference is to make the work of the Scientific Department better known to the industry and I look upon you as liaison officers between us and your own districts. I think that to fulfil this object most effectively it is very desirable that those coming to the Conference shall repeat these visits so that you may have a proper appreciation of the progress and the direction of the work. As there are two of you from every large district it should in future be possible for at least one of the two to have attended the Conference on a previous occasion.

I will now take the opportunity to tell you the programme for this Conference.

This morning I will give you a short report about the work done during the past year, After that a short account of some particular piece of work will be given by the individual officer concerned. This will probably fill the whole of this and tomorrow forenoon. In the afternoons commencing at 2. 0 p. m. I am dividing you into three groups. The groups will visit in turn every laboratory to discuss with each officer the work that he has been doing during the year. On Saturday afternoon after you have had the opportunity of discussing the work of the past year I will tell you the programme of work for this year. This should enable you to form some idea of the work done, being done and what we are endeavouring to do.

We shall rely on you to make this known in your different districts.

Before I give you an account of the work of the past year I think it would be appropriate if I ask Mr. Nicholl, the Chairman of the Indian Tea Association Calcutta to address you.

Mr. C. K. Nicholl, Chairman, Indian Tea Association Calcutta, then addressed the meeting as follows :—

Gentlemen,

This Conference, the first of its kind to be held is not merely to fulfil what was an important recommendation of the Engledow Commission, but is also the first attempt to deal with a many sided problem towards which attention is drawn time after time in the Report — the relationship between Tocklai and the Planting Community. I think in fact that it is true to say that apart from the purely technical recommendations regarding the direction and aim of experimental policy in Tocklai itself, there was no subject to which the Commission devoted more thought and upon which they were prepared to lay more emphasis than the various proposals made by them for increasing the intimacy of the contact between the Research Station and the tea districts.

The necessity for supporting these proposals has been fully accepted by the Committees both in London and Calcutta who have been studying the recommendations of the Engledow Commission and I am in a position to inform you that they have been accepted almost in their entirety. The appointment of three persons who will receive a specialised training to fit them for the duties of District Advisory Officers is now being proceeded with in London in consultation with Prof. Engledow. Additions are to be made to the staff at Tocklai in the near future to allow the resumption of touring and the question of the form in which the results of investigations at Tocklai are made available to planters will shortly receive the attention of the Scientific Department Sub-Committee. It will, however, be at least three years before these proposals can be implemented in their entirety. In the meantime we must rely for contact with the planting districts on the existing agencies, of which this conference must be considered one of the most important.

I desire to emphasise the importance of the part which the representatives of the planting districts here must play as a means of liaison between Tocklai and the tea districts because the general trend of research from this year onwards for a considerable period will be based on the recommendations of the Commission of Enquiry. As you are aware no radical change in the previous programme was advocated by them ; rather a difference of emphasis in certain directions, and a greater concentration of effort, but it is

a plan of work whose practical validity has been accepted by the most authoritative body of persons representing not merely scientific authority, but the interests of the commercial and producing sides of the industry which has ever examined the work of Tocklai. Its eventual success, however will depend upon the sympathy and the practical co-operation of the planting community when its results are eventually ready to be tested in practice and I feel that now is the time when the first seeds of that co-operation should be sown.

That, Gentlemen, I take to be the most important contribution which you in your capacity as representatives of the planting community can make at present to the work of the Scientific Department. We of the Sub-Committee and the members of the staff at Tocklai will be most grateful for the assistance which your criticisms and your suggestions into the plan of work which will be outlined during the conference will provide. But the greatest need at the moment is to re-establish that contact between the planting districts and Tocklai, so regrettably weakened by the financial exigencies of the period of depression through which the industry has passed and in the second place to make known the efforts which are being made to assist the tea industry by scientific investigations; and the practical purpose and aim of these investigations.

The attitude of the planting community to the work of the Scientific Department is of the utmost importance and in the words of the Engledow Report "it may be said in part to govern and in part to reflect the effectiveness of scientific work on tea". The ultimate purpose and the ultimate interest of scientist and planter are one and it is to be hoped that an active consciousness of this will continually inspire them. You are here as the most senior and influential members of the district planting communities. May I express the hope that during the three days of intensive work that lie before us you will study, appraise and observe and that you will return to the districts to carry back your first hand impressions of the efforts being made to assist the tea industry by scientific investigation, to explain the purpose behind the programme of work and its eventual aim, and to prepare the ground for the new offshoots of the Department in your district in the near future"

Chief Scientific Officer's Report on the work done during 1936 :—

Gentlemen,

The outstanding feature of 1936 is of course the visit of the Engledow Commission.

It is not required of me to deal in detail with that for you have all no doubt read the excellent report that has been published. The Commission visited the outstation at Tulsipara and remained at Tocklai for about 3 weeks.

One of their most important recommendations is for the appointment of Advisory Officers to the different districts. It is hoped that some of these officers will be appointed in 1937. It will be probably nearly two years before they actually get to work in their particular districts.

The necessity for such officers has long been apparent but financial conditions have not allowed of their being appointed.

In the past under normal conditions my policy in regard to visiting the different districts has been that a scientific officer should visit a district once in two years. Our staff did not allow of more frequent visits.

With, however, the necessity for retrenchment and the consequent reduction in our staff by two Europeans and 16 Indians it was impossible to carry on the work in progress at Tocklai and at the same time maintain the touring.

It was very evident to me that it would be a great mistake to stop the investigations that were in progress for to do so would mean a very great deal of experimental work wasted. I considered it therefore necessary to continue with the investigation work so far as the reduced staff allowed and to stop the touring.

I realised that this was a serious matter, for touring is an important part of the work of the Department and I hope that it will soon be possible to have a sufficiently increased staff at Tocklai to resume touring in the very near future.

In 1936 Mr. Harrison was on leave which left only Mr. Cooper to look after the field-work, the manufacturing experiments and the work of the Chemical laboratory which, I think, is more than one man should be asked to do.

This year Mr. Cooper and Mr. Tunstall will be on leave so that the position will be no better.

The cold weather Lecture Courses had originally been 3 in number but during the depression period were reduced to 2. The Engledow Commission recommended that these Courses should be brought back to their original number and we gave effect to this recommendation by holding 3 Courses during last November and December.

These Lecture Courses serve, in my opinion, a very useful purpose by bringing men to Tocklai to see the work that is being done and perhaps more particularly to appreciate the field experiments that are in progress.

It is very desirable to have at any one Course individuals more or less contemporary and it was in order to obtain this that a Senior Course was held. I am inclined to think that it would be an improvement if we had two Senior Courses and one for the junior members.

In fact I would like to see one of the Senior Courses reserved for Visiting Agents and Superintendents so that we might have an opportunity of showing the results of experiments to those who have to do with the formulation of garden policy.

Under the new Restriction Act we have been allowed to plant 16 acres of tea. This area has already been planted and we are now in the unfortunate position of not having permission to plant any more tea. I understand, however, that it is possible that a special grant may be given to us for this year.

I have to record the death of our Field Assistant Sj. D. Borpujari who had done good work for us for 22 years.

Turning now to the scientific work, this has been concerned in general with problems on the quality of tea and with finding the factors that affect the quality.

Throughout the manufacturing season weekly experiments have been carried out to ascertain whether phosphate or potash singly or together applied as manure in conjunction with 40 lbs. of nitrogen had any influence upon the quality of the tea made. The experiments along these lines have been carried out for several years but it was thought desirable to have a complete year's record. The results support those obtained in previous years.

The 6 Calcutta tasters have shown a significant but very slight improvement in the quality of the tea amounting to only $\frac{1}{2}$ pie per lb. from the use of phosphoric acid but the 6 London tasters do not show any improvement.

The use of potash has slightly lowered the quality of the tea made.

The use of phosphate has had a small but significant effect in increasing the crop. Potash has had no such effect.

Since the amount of phosphate and potash in the soil at Borbhetta is lower than in the average tea garden soil, it would seem that phosphate can be omitted from manurial mixtures containing 40 lbs. of nitrogen without fear of loss of quality of any practicable importance upon the present market and that potash can be omitted with the possiblity of a very slight improvement, if any, in quality.

It would seem, therefore, that with present market conditions 40 lbs. nitrogen alone may be used.

This is an important matter as it reduces the cost of manuring considerably. For instance 40 lbs. of nitrogen as Sulphate of ammonia costs Rs. 10/4/- whereas when combined with 20 lbs. of phosphoric acid the cost amounts to Rs. 13/6/-. By omitting the phosphoric acid the cost of manuring is reduced by approximately 24%. Whilst our present recommendation is that 40 lbs. per acre of nitrogen alone be used it must be clearly understood that this is a temporary measure. The soil is being depleted annually by the amount of phosphate and potash removed in the crop taken away which in the case of our experiment amounted to approximately 25 lbs. of potash and 10 lbs. of phosphoric acid for an average crop of 12 mds. per acre.

These experiments show that manuring when used in quantities such as is customary on gardens in North East India is not a factor that greatly affects quality. This is of importance, for often when a loss of quality has occurred coinciding with the use of manures in small quantities the blame has often been laid upon the nitrogen although the loss was most probably due to some other cause. In such a case a most careful search for such unknown factor must be made before attributing the loss to nitrogen. This experiment is not being continued, the results obtained over several years being confirmatory.

In 1935, manufacturing experiments showed that tea made from annually pruned bushes was better than tea made from bushes pruned biennially in the year that they were pruned. This experiment was continued this year when the biennially pruned bushes were unpruned. The result of the experiment shows that the tea from the annually pruned bushes is better than the tea made from the unpruned bushes. This experiment shows then that the annually pruned tea in each year has given the better quality. This effect is not however the same for all kinds of tea, the difference in quality varies with the different jats. The experiment was carried out with 4 jats of tea. In conjunction with this experiment the effect of jat of bush upon the quality of the tea made was also investigated and this factor—jat—is shown to be big in respect of quality. So far as our experiments go the best results have been obtained from a light-leafed Assam jat but both light-leafed jats did not give the same high quality. The experiment then has made very clear the necessity for a careful investigation of the jat of tea.

A casual observation of any area of tea planted with one jat, shows that the bushes differ in appearance as they also do in cropping capacity ; for instance, the best of 50 bushes in the Betjan plot gave $7\frac{1}{2}$ lbs. of leaf and the worst of the 50 gave $2\frac{1}{3}$ lbs.

The differences that occur within the jat may be associated also with differences in quality, and an experiment was carried out on 8 bushes of a light-leafed Assam jat to find out whether they gave the same or different qualities of tea. The results clearly show very considerable differences and it is evident that one of the first requirements in the investigation of jat is the examination of individual bushes.

I have used the word 'jat'. It is obvious that this word has but little meaning beyond indicating the particular seed garden from which the tea seed has been collected.

In 1935 attention was drawn to differences between the hairiness of different jats and a seasonal variation in the amount of hair has been found. The present work aims at analysing this variation into the components climatic and periodic change and the relations of these to cultural operations.

The investigation of the flushing and the banjhi periods of the tea bush has now been completed and an account of this work will be published

so soon as time permits. Some of the conclusions reached were reported in 1935. Further analysis of the data has show the relationship, between the nature of the branching system of the bush formed under the influence of plucking and the number of flushes which would be made by the same bush growing under natural conditions. The conclusion is that the natural flush periods of the plant set a limit to the number of times which a shoot can branch.

It would be interesting to know whether this observed relation is particular to the tea bush or is of more general occurrence.

I have referred to factors that affect the quality of the leaf as it is growing but there are other factors that affect quality. It is generally accepted that the best leaf brought to the factory may be spoilt during manufacture. We are investigating the conditions within the factory that may influence quality.

It has been shown that the development of bacteria on the leaf may greatly influence the kind of tea but it has also been shown that different bacteria behave very differently in this respect. It has been necessary consequently to devote time to the study of the different kinds of bacteria. These at present may be divided into 3 large classes known as the "Blue" "O B" and 'O.' I need not enter into any discussion for this nomenclature as it is purely of a technological nature.

The Blue are largely destroyed in the early stages of rolling so soon as juice is squeezed out of the leaf on its surface.

The O B are also to some extent controlled in the same way.

The first of these two classes can not then play any active part in factory infection.

The O class however includes those organisms that develop in large numbers in the factory and a detailed study of these is therefore required.

It is evident that there are many kinds affecting the quality of the tea differently.

It has been necessary in this investigation to spend a large amount of time on purely technological matters for instance it has been necessary to develop a technique that gives a differentiation between different bacteria. This has and in fact still is occupying a very great deal of the time of this Branch. It has also been necessary to give much time and attention to

sampling difficulties, to find out what amount of replication is necessary to give the required reliability to the results. This is a very important matter since the numbers of cultures can so easily become overwhelmingly large and it is a first consideration to keep the number within workable bounds. Work along these lines is proceeding and must precede work of a more commercial interest.

Experiments have shown that leaf allowed to get hot in the plucking baskets may develop a high bacterial count and these may be of such organisms as can adversely affect the quality of the made tea. Determining the different bacteria that do harm and how, when and where they develop on the leaf is a matter of much importance for having that knowledge it will then be possible to devise methods for the better control of such organisms. In the meantime it is evident that more and more attention must be given to controlling bacterial development in a factory with the methods that are at present available. I take this opportunity of pointing out that a factory which takes no precautions about bacterial control may make excellent tea because the particular organism developed in that factory is not noticeably harmful but a change to a harmful species may take place at any time with disastrous results. A clean factory does given a greater likelihood of producing a good steady quality of tea. A clean factory is the safer.

Planters have generally held the opinion that a high temperature in the fermenting mal is detrimental to the quality of the tea but it has been unknown whether this was a direct effect of the temperature upon the chemical reactions of tea fermentation or whether it was an indirect effect by stimulating the development of bacteria in the fermenting mal. Preliminary laboratory experiments carried out in 1936 have shown that temperature has a direct effect upon fermenting leaf. It is too early to report more than this but the work is being pursued during 1937

The Mycological work cannot be said to be directly connected with the quality of the tea made but it is nevertheless very important for controlling diseases that materially affect the health and cropping capacity of the bushes. It is therefore an aspect of our work that must not be overlooked whilst we are paying so much importance to factors that affect quality.

Carefully designed and replicated experiments have been carried out in 1936 to ascertain the relative values of Burgundy and Lime-sulphur sprays for controlling Black Rot. The resulty show that both these sprays are effective but that the Burgundy mixture is the better. Further work is

needed and is indeed in progress to determine the best method for applying the spray fluid.

Our recommendations at present are that the spraying should be applied only to those bushes that are attacked and so soon as it is seen that they are attacked. Further experiments however are needed before we are certain of the best and most economical method.

By far the greatest number of bushes that are sent to us for finding out the cause of death are those that have had an infection by some organism through a pruning wound, often a wound made when heavily cutting back. An experiment was commenced in 1936 to find out whether the development of callus over the wound could be made more rapid, and what effect different wound paints had upon the effect of callus growth and keeping the unhealed portion of the cut free from disease. A noticeable feature in the first year of the experiment is the increased growth of callus on cuts treated with bitumen. Leaving varying lengths of new wood before plucking has also had an effect as also whether the cut is near to a growing shoot.

It is very desirable that cuts be kept free from infection until the callus has completely grown and gives protection but at the present time there are a large number of bushes suffering from disease that has already found entry through unhealed cuts and attempts have been made to find some means of treating such so as to kill the organism that is already present in the plant tissue. So far we have not succeeded but work is in progress and will be continued for the problem is of great commercial importance.

In the field experimental work a new clearance of 6 acres has been planted to give us information in regard to the response of 12 different jats of tea in respect to nitrogen manuring and to shade and no shade. It is necessary to know the difference in behaviour of the different kinds of tea under the same conditions. This completes the area which we are allowed to plant under the present Restriction Act.

A new clearance planted in 1935 has afforded us information in regard to the behaviour of young plants under adverse climatic conditions of drought followed by hail in the spring. The results show that the light-leafed jat has proven to be a little more delicate to such conditions

Another point that is of much interest is that the use of 300 lbs. of Sulphate of ammonia per acre in April has resulted in slightly but

significantly more deaths than on the areas manured with 100 lbs. of Sulphate of ammonia per acre.

The Sulphate of ammonia has a depressing effect upon the plants for about 3 weeks after application and this on the top of the severe climatic conditions when leaf area was small proved too much for some of the young plants.

Delaying the manure until the young plants have a good amount of leaf (June) is to be preferred to too early manuring.

Whilst no new cultivation experiment has been started yet the existing experiments as time goes on, become of increasing interest from a commercial point of view as indicating possible ways of reducing unnecessary expenditure and limiting the cultivation to that which is essential. The results of 1936 confirm those of previous years that the suppression of jungle-growth should be the main object of cultivation and that soil stirring in itself has but little effect. The cheapest and most efficient method of jungle suppression still remains as the cultvation method that should be adopted.

Experiments pertaining to quality of the tea are justly occupying our chief attention yet experiments to maintain or increase the crop per acre must not be neglected for the larger crop per acre is generally associated with cheaper production cost and consequently manuring experiments are still of importance.

A great deal of interest now-a-days is being given to the preparation and use of vegetable composts for manuring. We have made experiments with the preparation but it is too early yet to say what is the result of their use as a means of increasing the tea crop and quality.

A considerable number of analyses of composts have been made by the Chemical Branch throughout the year. We have also made weekly estimations of the nitrates present in the soil from plots manured with composts and plots manured with mineral manures only in order to find out how soluble nitrogen becomes available to the plant in the form of nitrate. So far in this experiment the compost does not show to advantage but further results must be awaited before forming any conclusion

Our field experiments show that there is no permanent gain, as is sometimes claimed, from the use of cattle manure. The big single dressing of 20 tons of cattle manure gave marked effect over the four following years but has been without further residual effect over the past two years.

Our experiments continue to show the relative greater efficie
Sulphate of ammonia compared to any other manure, organic or inor
that we have tried. It is the cheapest of all forms of nitrogen and we
regard it on the evidence that we have as the manure generally m
suitable for tea so long as its present low price is maintained.

Sulphate of ammonia broadcast can be allowed to remain on the soi
surface without being hoed in without any *loss of efficiency. Our experi-*
ments over two years show that the manurial effect is the same whether hoed in or left on the surface when applied in the spring to flat land.

A series of plots on which different quantities of nitrogen are applied in inorganic form, since 1930, shows an increase in the organic matter content of the soil on those plots receiving a heavy dressing of the manure. These results very definitely dispose of the idea that the use of mineral manures for tea necessarily depletes the soil of organic matter. I need not say more upon this very entertaining subject for Mr. Cooper is going to give you a short talk about this.

Pruning experiments have shown that pruning early in the cold weather results in a greater proportion of the crop being obtained during the second flush period when good teas are being made.

It has also been shown that clean pruning annually gives a greater crop at Borbhetta than does cutting across.

It is however impossible to clean out and prune early the whole of the garden and an experiment was carried out to ascertain the effect of cutting across early and cleaning out in a subsequent operation. It was shown that whilst this may add 20% more to the cost of the pruning yet the cleaning out is done when it is difficult to find useful work for the labour and therefore it does not add to the garden expenditure and by getting the cutting across done early a great deal of the benefit of early pruning is secured.

It was not however known how much cleaning out was necessary as this can vary between mere removal of banjhi shoots to the excessive cleaning out of stick pruning.

An experiment was therefore started to find an answer to this. The first year's results show the best crop return from the cleaning out that removes no more than banjhi shoots. Any removal of other shoots lowers the crop. It will be necessary of course to carry out this experiment for

a number of years before final conclusions can be drawn but the results so far indicate that cleaning out should not be carried to any severe extent.

The experiment in heavy pruning at the end of the 9th year still shows that the medium pruning at 18" is significantly better in crop than the collar-pruned tea. The collar-pruned tea today looks no better than the medium pruned tea. There is no evidence so far of anything but loss from the collar-pruning.

The plucking experiments have shown that sparing the bushes by leaving longer growth at the beginning of the season results in a loss of crop during the second flush period.

An experiment was therefore initiated to ascertain the effect of plucking on a short length of new wood until the end of July and then sparing the bushes during August when rains quality teas are being made. The results so far show that plucking to 4" of new growth and then to the janum until the end of July, then raising the plucking height by two leaves has given the same total crop as plucking to 8" and then leaving a leaf once only, but the more severe early plucking has given a crop of 4·8 mds of tea per acre to the end of July compared with 2·8 mds of tea per acre from the 8" plucking or an increase of approximately 73% of crop up to the end of July

The field experiments at Tulsipara continue to give interesting results The most striking for 1936 are

(1) The remarkable success of unpruned tea :—The unpruned having given an average of 19-9 mds. of tea per acre compared with 11.4 mds. per acre from annually pruned tea. Such success is difficult to explain, since though Red Spider was absent this year it was also very little in evidence in 1934 when the tea was last unpruned and when much smaller increases were obtained. Certainly early spring drought in 1936 which almost completely defoliated the unpruned tea seems to have had no adverse effect on the unpruned tea.

(2) The slight but nevertheless significant good effect of sulphur applied to soil already considered sufficiently acid for tea. The value of the crop increase of about $\frac{1}{2}$ md. per acre is far short of the

cost (Rs. 35/) of the 400 lbs of sulphur applied per acre but it remains to be seen : —

(a) whether such increase is maintained without the further addition of sulphur.

(b) whether in the event of Red spider attack the sulphur-treated plots remain freer than the untreated plots with the resulting further increase in crop.

In North East India field plots have been laid out in 30 tea gardens.

We wish to increase the number of these experiments as much as possible and I should like to suggest that we cannot remain satisfied until every tea garden has its own experimental plots."

Mr. Irving requested that copies of the foregoing speeches and the Report be circulated to the members. The Chairman replied that a complete account of the Conference would be sent to each member.

Mr. Cooper then addressed the meeting on the subject of organic matter in tea soils, as follows :—

This subject has been forced on to the notice of many of you following the lectures given by Sir Albert Howard at meetings of the Royal Society of Arts, and as it is a subject of great interest from the scientific as well as from the practical side, it is proposed to confine the present discussion to this aspect of the manuring problem.

All forms of organic matter used as manure contain nitrogen, and all will agree that at least a large part of the value of any form of organic matter as manure, arises from its power of supplying nitrogen which is available to the plant. The difficulty lies in deciding whether the organic matter possesses any virtue apart from the nitrogen it supplies.

Organic manures might conceivably prove superior to soluble artificials in several ways.

(1) Being insoluble in water they cannot be washed out until converted into soluble form. In general, the conversion of the insoluble nitrogen they contain into soluble form is relatively slow, and some of them might, very conveniently, produce soluble nitrogen at just about the same rate as plants can take it up. It has, indeed, been quite commonly assumed that things like cattle manure or vegetable composts have this desirable characteristic. It has, on similar lack of evidence, been assumed by some that artificials give a large increase in growth over a short period and then no further effect.

We have even read and heard opinions to the effect that artificials are not food at all, but merely stimulants, while the bulky organic manures provide real plant food. Such opinions of course are held and expressed only by a few of the more ignorant, but are common enough to deserve some notice.

Plants of course can take into their systems, through their roots, only such substances as are soluble in water. In any normal tea soil, any form of organic matter is converted first slowly into ammonia which then changes very rapidly into nitrate. It is as nitrate that the tea bush takes at least most of its nitrogen, and it makes no difference to the tea bush, as far as its nitrogen ration is concerned, whether that nitrate came from nitrate of soda, from sulphate of ammonia, or cattle manure ; or even from a humus compost, with whatever ritual it may have been prepared.

The supply of soluble forms of nitrogen is of enormous importance to any plant, and it is of particular importance to tea, but it is not necessarily the whole story. Tea, like other plants, requires other substances also.

(2) Other substances than nitrogen are supplied by the bulky organic manures, at any rate. We will not here discuss potash and phosphoric acid. They are of small importance to tea, and in any case can be supplied with perfect efficiency by artificials. Neither will we discuss other elements also necessary to plants. With regard to tea there is very little evidence on this subject to discuss. There is however the possibility to be borne in mind that bulky organic manures, collected over a large area and applied to a small one, might sometimes do better than an artificial by increasing the supply of an element in which the soil was deficient. It may also be mentioned that cases are known where bulky organic matter has proved to be beneficial because it has caused iron present in the soil in unavailable state to become available to plants, and plants cannot grow without iron. Such a case will not arise on an acid tea soil manured with sulphate of ammonia and receiving regular additions of prunings.

What has to be discussed here is the possibility, on which so much stress has been laid by Sir Albert Howard, that fermented vegetable material may supply auxiliary food substances akin to the vitamins necessary in the food of animals. Sir Albert, in fact, does not content himself with stressing possibilities. He states confidently that fermented composts do contain such substances, and that the use of fermented composts in concequence will prevent the occurrence of disease in tea, and will improve the quality of the product.

With his claim that the manuring of fodder crops with the composts will prevent foot and mouth disease we need not here concern ourselves.

(3) The presence of a sufficiency of organic matter in the soil may produce improvements in texture and other physical properties which are of value. There is evidence that drought resistance is increased, and that the property known as "tilth" may be improved.

(4) Even though they may be of lower efficiency, per unit of nitrogen, than an artificial, the application as manure of what otherwise would be

wasted may prove cheaper than the purchase of an artificial giving the same effect.

These are the problems on which I propose to explain to you such evidence as already exists, and the work proposed in search of further evidence.

From now on I must leave Sir Albert Howard out of the discussion. He has rendered valuable service in arousing interest in the subject, and in pointing out possibilities of profitable use of waste material; but all his assertions rest on pure speculation, and he has produced no evidence whatever in support of his assertions, so that we have nothing from him which we can discuss.

I will however endeavour to cite such evidence from other sources as is in favour of his contentions.

1. Slow against rapid action.

The supposition that tea must have small quantities of nitrogen continually available to it has been disproved. A single dose of 600 lbs. sulphate of ammonia gives just as great an increase in crop as 8 monthly doses of 75 lbs throughout the growing season. Sulphate of ammonia is not washed out. After a single big dressing of sulphate of ammonia, the nitrate content of the soil remains high over a long period, and its effect on crop is significant five years afterwards. A dressing of cattle manure supplying as much nitrogen showed certainly a much smaller effect in the first year and a smaller total effect, but no greater effect in the following three years, and no effect in the fifth or sixth years.

In the respect tea differs from annual crops. It can, in some way, store and carry over such nitrogen as has not been used. This storage probably is largely in the form of a bigger bush, but the increased quantity of prunings following the use of an artificial must also assist, by allowing storage in the bodies of the soil micro-organisms which break down the prunings, and in the more resistant dead nitrogen compounds formed

"Slow" action usually means inefficient action. At Borbhetta, the total effect of cattle manure per unit of nitrogen is about half that of sulphate of ammonia, while such materials as sinews, hide, and hair give very little effect even in the seventeenth year of continuous application. Not all organic manures are slow. Horn meal in the moist warm climate of Assam is practically as rapid in action as sulphate of ammonia. The green leaves

(without previous composting) of boga medeloa also are rapid in ac
With regard to the crop of tea we are not afraid of rapidity of act
because effects which start to show quickly, also last long.

Quality is reduced extremely little by moderate dressings of nitrogen, but is reduced increasingly as the dressing of nitrogen increases; yet no difference in quality could be detected between teas manured annually per acre with 300 lbs. sulphate of ammonia and 5 tons cattle manure respectively, though the former gave double the increase in crop.

If the effect of an artificial on quality should be found deleterious, it would be better to use a smaller quantity than to substitute an organic manure to supply the same amount of nitrogen of less efficiency for crop, at a higher price.

(2). In support of the supposition that fermented organic matter, may provide substances akin to vitamins, I have been able to find a few experiments recorded.

The first is that of Viswanath at Coimbatore. He compared seed from unmanured plants, with seed from plants manured by cattle manuare and by artificials respectively. He showed that the germinating power and the crops produced when the different seeds were sown under similar conditions were in the following order :—

Cattle manure	best
Sulphate of ammonia	next
No manure	last

His experiments on the seed were replicated and it was shown that these differences between the three classes of seed were significant. The plots from which the seed was obtained however were not replicated. The plants grown on cattle manure, sulphate of ammonia and no manure respectively were grown on only one plot each, and there is nothing to show that the differences between the three plots and not to the manures used. We need not stress that point, since there is another of more importance. That is that the cattle manure plot had received, over many years, 5 tons manure annually, while of sulphate of ammonia only 1 cwt. was used. No analysis of the cattle manure is recorded but it must have supplied at least three times as much nitrogen annually as did the sulphate of ammonia.

If we are to accept the superiority of the cattle manure seed as proof of the presence of some valuable auxiliary food in the soil how are we to

explain the superiority of the sulphate-of-ammonia-fed seed to that from the unmanured plots ? Is it not a more reasonable explanation of the differences that seed was better according as the parent plant was better fed with nitrogen ?

McCarrison used grain from these same 3 plots, for feeding pigeons to determine the relative contents of vitamin B. He reports superiority in this respect for the cattle-manure, but apart from the fact that the seed was grown on single plots only, this results on the grain are not sufficiently greatly different to be regarded as anything but indications of possiblities ; while here again any difference could be ascribed to the difference in quality of nitrogen supplied It is normal for plants to manufacture vitamins, and it is quite possible that the efficiency of this manufacture is increased by a sufficiency of food. The same objections apply to the experiment of Rowlands and Wilkinson who report that the vitamin B content of grass seed was greater from land manured with artificials. Their experiments again were on single plots only, and they compared 1 cwt. of sulphate of ammonia with 20 loads of dung per acre.

Against these two inconclusive trials is the evidence of L. B. Harris of Cambridge on feeding rats with whole-meal grown with different manures, obtaining the following relative values,

Farmyard manure	80
Complete inorganic manure	120
Sulphate of ammonia	120

Schreiner and others at Leipzig also fed rats on a mixed diet grown on plots manured respectively with cmplete inorganic manure and "natural" organic manures. No injurious effect showed from long-continued feeding on food grown with artificials only. On the contrary, the artificially manured food produced longer life in the rats and greater resistance to disease, with the females ratained their fertility longer and produced more robust offspring.

Evidence in favour of auxiliary food substance from field experiments on the subject, then, is at best inconclusive.

Sir Albert Howard objects to results from experimental stations as "divorced from practice." What he means by that he does not explain, and I for one cannot guess. The differences between results of experiment in the field and results in practice are two. First, the former are (or

should be) designed accurately to separate the different factors in while differences in practice arise from many factors, working to which cannot be separated That surely is no discredit to the experi stations.

The second difference is that experiments have to be perform relatively small plots: in fact, on samples of the land. The va anything is always determined from samples. Modern field expe use so many samples that their average is accurate, and there are methods of assessing that accuracy.

You who are content to sell a break of thousands of pound of tea for a price based on the tasting of a single small tea-spoonful, will surely not object to having the value of your manures assessed on their action on a large number of small plots of tea.

Sir Albert Howard however, receives the strongest support for his assertions from experiments so far removed from agricultural practice that they were performed on a pond-weed grown in solutions contained in little glass dishes in a laboratory.

The researches of Mockeridge on Lemna minor afford very interesting proof that during the fermentation of a nutrient solution by yeast, substances stimulating to plant-growth are formed.

There is a strong possibility that similar substances may be formed during the decay of heaps of vegetable matter, which may account in part for the efficiency of the leaf-mould beloved by gardeners. Assuming that such substances are so formed, there is still no reason for believing that the desired reactions cannot go on eqally well when the decay is allowed to proceed in the soil itself.

Proof of the presence of such substances in humus composts is still lacking : while, on the other hand, it is proved that, under certain circumstances, substances harmful to plant growth may be formed during the decay of organic matter. A great deal of work therefore is necessary, using raw-material from different soucces, and rotted under different conditions before, any opinion on the subject is possible.

3. Organic matter and physical condition.

The improvement of physical condition of the soil by incorporation of well-rotted organic matter, I think we can accept as a result of experience everywhere. It is a necessary to point out however that it is also

common experience that very large quantities of any form of humus material have to be applied before any such improvement in tilth can be noticed. To take an example, a heavy Surma Valley flat is a first class tea soil requiring no manure for many years, if it has 12% "loss on ignition", and (though it grows moderate tea) it is a nasty sticky clay if it has 5%. The top-spit of the soil may be taken to contain about 3.000,000 lbs. of soil, so that a difference of 4% means 120,000 lbs. of dry organic matter. It would require about a million lbs. of such humus composts as are made on gardens to supply this quantity, and that of course would not all remain in the soil. Additions of this order are not impossible on a market garden. The maximum possible on a tea garden in different class altogether.

I do not think you will be able to pick out at Borbhetta, from their physical texture, soils which have had 10 tons cattle manure annually for 6 years from those which have had no manure, though you will certainly pick them out when similar treatment has been carried on for 20 years. The 60 tons applied so far have supplied about 15000 lbs. dry organic matter, equal to 0. 5 per cent of the top spit of the soil. Of this probably a good deal less than half has remained, and sampling error is so great that we have not yet been able to show by analyses that the gain in organic matter is significant, although it must be true that there has been a gain.

On the other hand where we have applied artificials only for the past seven years we have obtained the following results on analysis of the soil.

lbs. artificial nitrogen annually for seven years.	per cent of dry soil	
	loss on ignition (organic matter)	nitrogen
0	2.80	0 094
40	2.93	0.096
80	3.09	0.101
120	3.10	0.104

Soil organic matter does not consist of carbon compounds only. Nitrogen is an essential part of it. The percentage of soluble nitrogen in November, when the samples were taken, was negligible, and the nitrogen figures provide evidence of the quantity of soil organic matter presents.

It will be observed that the ratio of "loss on ignition" to nitrogen is roughly constant at 30 to 1, or $3\frac{1}{3}$ per cent nitrogen in the organic matter.

The errors of the experiment are such that the differences per 40 lbs. nitrogen are not statistically significant, but for any increase of 80 lbs nitrogen the difference is significant.

Artificials therefore do not "exhaust the soil" but we have definite evidence that they improve it. The difference in soil condition between 80lbs. nitrogen annually and nil, was clearly evident to so close an observer as Mr James Insch of Duncan Bros. when he inspected the plots last February, and it was his hint which made us think the results, here quoted, likely to be worth getting.

The results are not so surprising as may appear at first sight.

You all prefer to plant tea on land newly opened from jungle rather than on soil after 50 or 60 years of cultivation. Whence does the difference arise ? A soil carrying untouched plants loses little by washing out because the rate of nitrification (breakdown into nitrates) of the soil organic matter is greatly retarded by the close occupation of the soil by roots ; while such nitrate as is formed is very largely taken and held by the plants. Meanwhile falling leaves and dying plants and animals continually add to the soil organic matter. Some of these plants are legumes which fix nitrogen from the atmosphere through the nodule organisms on their roots ; but, even in their absence, other organisms, free-living in the soil, have the power of fixing nitrogen from the atmosphere if provided with carbohydrates such as for example' the cellulose in leaves. Hence soil under jungle gains in organic matter and in nitrogen.

A soil under good tea closely approximates to soil under jungle. The spaces between lines of poor tea (and unmanured tea at Borbhetta soon becomes very poor) approximate fairly closely to a bare fallow, under which conditions, losses of nitrogen and organic matter are very rapid.

From the good manured tea we get not only close cover but a greatly increased quantity of prunings for annual burial, as shown below :—

lbs. nitrogen per acre annually as manure for 7 years.	Crop, Mds. tea per acre, 1936.	prunings per acre December 1936.		
		gross weight in tons.	tons dry organic matter	lbs. nitrogen per acre, prunings.
0	6.3	2.86	0.90	40
40	9.7	4.10	1.43	60
80	13.9	5.41	1.89	80
120	16.4	6.36	2.23	94

In addition to increased leaf-fall ; 80 lbs. artificial nitrogen per acre produce about a ton of dry organic matter annually in increased weight of prunings, and much of this is woody matter likely to produce, when rotted down, a form of "humus" which would remain in the soil.

Hence our normal experiments with artificials do not provide evidence on what is likely to happen in a soil which becomes deficient in organic matter. We are trying experiments including plots from which prunings are removed. In the second year the results show a loss of 1. 4 mds. tea per acre from the plots from which prunings are removed. I hope that those few of you who remove and burn prunings will stop the bad practice So far, the effect on crop of the prunings per unit of nitrogen is very small compared to that of artificials, and that gives reason to expect that much organic matter is remaining in the soil. Meanwhile sulphate of ammonia is giving as much crop increase on soils from which prunings are removed as on soils where the prunings are buried.

This experiment, however, we look upon as mainly of academic interest. If we do find eventually that we cannot maintain crop. health, or quality on soils from which organic matter is excluded, we know that the use of artificials on tea carries with it automatically a very full supply of organic matter, and have no fears on that score, provided that prunings are returned to the soil.

4. Cost.

We are unable to devise experiments which will separate the effects of the three factors possibly concerned when organic matter is applied to the soil. All that can be done is to compare the sum total of these effects with those of an artificial.

Experiments on tea, at Borbhetta, at Tulsipara, and at Halem so far show that for the same quantity of nitrogen, cattle manure is inferior to artficials. Similar results are obtained on any crop wherever experiment has been made. Even the assumptions commonly made that fruit and vegetables must have dung have never been proved. Some, at least, of the common failures of artificials compared to dung in garden practice are due to the inefficiency of the dung as a supplier of available nitrogen the tendency being to overdo artificials on small areas where cost is of little importance.

If dung does provide useful auxiliary food substances, their value for tea is outweighed by the lesser efficiency of the nitrogen compounds contained in the dung. But even though the efficiency of the dung per unit of nitrogen may be small, it may be possible to apply such large dressings so cheaply that its use is economical compared to artificials. An accurate experiment at Halem for example, so far shows cattle manure to have about one third of the efficiency of sulphate of ammonia per unit of nitrogen ; yet organisation, and perhaps natural advantages, make it possible to produce a larger increase, per rupee spent, from cattle manure than from sulphate of ammonia.

In this case (Mr. Burton will correct me if I go wrong) only the costs of carting and spreading are charged. The cost of collection is charged to the necessary cleaning of lines. Here, then we have a case of the utilization of a real waste product. If collection were expensive profits would be reduced, compared to the use of sulphate of ammonia.

Another case of very efficient organisation in preparation of bulk organic matter, in this case compost, on a very large scale, is that of a garden in South Sylhet. Here with all costs charged to the manure a 5-ton dressing costs about Rs. 17/- applied. Accurate trials are now starting on this garden, and I am pretty sure that 5 tons compost will prove less efficient that 200 lbs. sulphate of ammonia costing about Rs. 12/. If, however, what used to be expended on cleaning the lines is subtracted from the cost, the use of compost probably will pay.

On the present evidence we think composts likely to prove about as efficient as cattle manure, and their probable value, applied, to be generally not above Rs. 2/- per ton. This, of course, is a very rough guess, because no results of experiment are yet available over a suffi-

ciently long time ; but they generally will cost about Rs. 5/- per ton if all costs are charged. Our opinion then is that they can be used only so far as they are by-products of some other necessary operation to which part of their cost can be charged, or as an occupation for coolies at times when no other remunerative work is available for them. But we hope not to find that composts or cattle manure are being collected at excessive rates, even in the cold weather when there is no pressure of work, on gardens where the cost of decent pruning is not afforded.

We would advise you to collect all the cattle manure, urine-impregnated bedding, and such other organic rubbish as must be collected from the lines, like old thatch from the houses, and such jungle as must be cut in and around the lines or elsewhere, and to compost the lot together. We cannot advise special cutting, for the purpose of manure making, of jungle at any distance from the place where it will be applied.

The suggestion which has been made that prunings and cuttings of green manures should be collected from the area under tea, carted to the compost pits and then carted back again to the tea, strikes us as fantastically absurd. Such procedure entails no addition of foodstuff which would not have been applied to the soil without cost. It assumes that there is some special virtue in fermentation off the land Where heavy dressings are to be applied to annual crops there is such an advantage. The first effect of a dressing of organic matter poor in nitrogen is depletion of the soil's available nitrogen by the soil's organisms which require available nitrogen for their work in breaking down the material, and the crop sown over such crude organic matter would be starved.

Pre-fermentation gets over this reaction, off the land. The organic matter is broken down and disappears as carbon-di-oxide gas, leaving a material which has lost very much more organic matter than nitrogen, and hence has a higher ratio of nitrogen to organic matter, and is ready for nitrification when applied to the land.

The average of the many composts we have examined is about 12% organic matter (about 88% being water and ash) with about 0.4% nitrogen or a little more—say about 3½% nitrogen in the organic matter or about the same as in soil organic matter. Green manure cuttings before composting have about the same ratio and are fully as ready for nitrification.

To compost them can only mean loss of nitrogen. Annual prunings of tea have about 2% nitrogen, or a little less, in their organic matter and would be rendered more readily available by pre-composting ; yet the ratio is not far wrong, and we have been unable to detect any loss of crop from normal tea, at any time, from plots where prunings are buried compared to plots where prunings are either removed, or left unburied Prunings from land yielding 20 mds. tea per acre do give a temporary loss in early crop when they are buried.

The chance that some auxiliary food substances akin to vitamins may be formed in a compost heap, and not when the same material ferments in the soil, is much too remote to be worth any cost at all.

A discussion followed in which Messrs. Burton, Graham, Irving, Rainey and the Chief Scientific Officer took part. Mr. Burton stated that he was in a position where he could supplement his own supplies by cattle manure purchased cheaply from neighbouring villages, and so could obtain enough line or cattle manure to treat 30 per cent of his garden with 200 mds. of good humus manure per acre ; but his experience was that not more than 25% of the garden could be so treated economically. The limiting factor was the area of tea suitable for economical carrying and spreading and efficient supervision. Application of bulky manures in high close-grown tea is extremely difficult.

Mr. Graham thought that the limiting factor governing the area which could be treated with compost, was generally the amount of compost which could be profitably made with labour which otherwise would be unemployed. The Chief Scientific Officer stressed the need for using labour in the most efficient way. On some gardens for instance, they could be more profitably employed in better pruning than in preparation and application of humus compost.

Mr. Tunstall then addressed the following remarks on the subject of Black Rot in tea : —

The most important leaf disease at the present time is undoubtedly Black Rot.

History.

Black rot is not a new disease. Watt and Mann refer to epidemic Grey blight in their book on the Pests and Blights of the plant. This almost certainly was Black rot.

In the Assam Valley the first outbreak of this disease I investigated was in 1915 when I identified the fungus as Hypochnus theae.

Dr. Bernard had already described this fungus which he fund on tea in Java. Quite independently Mr. Petch in Ceylon described a similar fungus which he called Corticium invisum. The generic name Corticium was also adopted for Hypochnus theae which then became Corticium theae. Both Corticium theae and Corticium invisum are associated with Black rot in North East India Although distinct species they frequently occur on the same areas and in fact on the same tea bushes.

On the garden referred to above the disease was causing little damage and no treatment was carried out until 1918 when it began to cause serious loss on one section. I personally supervised the treatment and the disease was brought under control. On a neighbouring garden nothing was done and the disease very soon became general and continued to cause serious loss for a number of years. In 1916 I saw a severe outbreak on a garden in Cachar. I have since found it in all the tea districts of North East India.

For a number of years I was under the impression that the outbreaks that occurred in the middle of the rainy season were due to the fruiting of the fungus on a few bushes on which the fungus had survived the previous cold weather. The treatment of all bushes showing signs of infection at the time of pruning was therefore recommended. In most cases this was apparently successful. For some years there did not appear to be any necessity for further treatment. It was also noticed by Shove in Doom Dooma that if a bush attacked by Black rot were allowed to remain unplucked the disease apparently disappeared from that bush.

Cases which failed to respond to cold weather treatment began to accumulate and it became obvious that in some areas at any rate a supplementary treatment was desirable. Lime sulphur solution was found to check the growth of the fungus and enable the diseased bushes to give a satisfactory crop. In spite of constant spraying with lime sulphur however the number of bushes requiring treatment did not diminish to any great extent. At that time the financial condition of the industry did not warrant high expenditure on blight treatment. As soon as financial conditions showed signs of improving experiments were put in hand to find a treatment which would give more permanent results. Such experiments involved considerable expenditure as they required to be carried out on the gardens concerned and our sincere thanks are due to the various agency houses and garden managers who assisted in our experiments.

Description.

The disease is called Black rot because in wet weather badly attacked leaves and shoots have a black, rotten, appearance. When they dry the diseased leaves are mottled with brown and grey patches closely resembling those of Brown and Grey blights (very frequently the dead tissues are attacked subsequently by these blights.) There are however a few points of difference. In the case of Black rot the dead patches are often small and scattered and their edges are irregular while those caused by Brown and Grey blights are more frequently larger, less numerous and with well defined edges- When the Black rot fungus is actively growing it is usually possible to find small cushions of cream coloured fungus holding leaves together at points of contact. The general appearance of a bush attacked by Black rot closely resembles that of one attacked by Thread blight. As with Thread blight the diseased shoots occur in patches on the bushes and it is not usual for diseased leaves to be scattered all over the bush as is the case with Brown, Grey and Copper blights. In dealing with this disease it is well to assume that any bush which appears to be attacked by Thread blight requires treatment whether threads are visible or not.

The two species of Corticium which cause Black rot differ in two respects. With Corticium theae definite threads are formed. As these are just the same colour as the reddish brown bark they are not easy to distinguish. Corticium invisum produces no visible threads. The two fungi also differ in their fruiting stage. In both cases the fruit is formed on a green

and apparently healthy portion of the leaf. In the case of Corticium theae the fructifications form a brownish patch of dust on the under-surface of the leaf. Those of Corticium invisum are generally less brown and less easily seen. In both cases however the frucfications are very easily overlooked. They are produced most frequently in the earlier part of the rainy season.

Under the microscope it may be seen that the Black rot fungi are wholly external. As in the case of Thread blight the fungus does not actually penetrate the tissues of the tea plant. They do however enter crevices in the bark and holes such as those left by dead snags.

The dissemination of the fungus.

In order to obtain accurate observations it was necessary to keep track of the blight on large numbers of individual bushes. This was done in the course of a number of experiments in treatment. The individual bushes found to be infected were marked on charts or in specially ruled books. Where possible the bushes were examined at each round of plucking. In other cases once in each month had to suffice. Observations taken in this way over two years show that when untreated the percentage of visibly infected bushes increases from the beginning of the rainy season until July or August but as the weather become dryer the number decreases until at the end of the season three quarters of the bushes, obviously infected in July, may appear to have recovered. This recovery is only apparent however as in the following July most of the same bushes are found to be still infected.

In the Assam Valley there is little evidence of a rapid increase in the number of bushes newly infected. The rapid increase in the percentage of obviously infected bushes in the middle of the rains is not the result of new infections but of a renewal of the activity of the fungus on previously infected bushes. In the Surma Valley there is a greater tendency for the blight to spread from an infected bush to its immediate neighbours. Even in the Surma Valley a rapid increase in the number of newly infected bushes seems to be the exception. It would appear therefore that distribution on a large scale such as might occur from wind-borne spores is unusual.

Factors affecting the percentage of bushes infected.

Observations on the percentage of bushes under shade trees and that on adjoining unshaded areas showed that shade had no apparent

effect. Careful pruning out of all the apparently diseased material and the removal of all the prunings failed to effect any improvement in the following season. Stripping the infected bushes of all leaves did not prevent a reuival of the fungus when the new growth appeared. The undue reduction in leaf area caused by stripping would do more harm than the blight and as it does not remove the fungus it has nothing to recommend it.

The pulling off of most of the badly infected leaves and dropping them on the ground just before the spray fluid is applied however facilitates spraying and makes it easier to spot a revival of the fungus. This is useful as it enables a second application to be applied, when necessary, without undue delay. It should be emphasized that there is no advantage in removing all the diseased leaves – the bulk of them are pulled off merely to facilitate the later treatment.

Soil conditions, jat and condition of the tea bushes also had no apparent effect on the percentage of bushes infected.

There is however no doubt that areas of tea more or less surrounded by heavy jungle or by high teelas have a much higher percentage of bushes infected than those more exposed.

Factors affecting the damage from Black rot infection.

Black rot causes damage by reducing the effective leaf area. The percentage of leaves is therefore more important that the total number of leaves infected irrespective of the total leaf area on the bushes concerned. The amount of leaf remaining on the tea bush is therefore a very important factor in determining the damage caused by the blight. An unplucked bush with plenty of leaf may be attacked by Black rot without suffering much damage while the same amount of blight may cause serious damage to the same plant were the latter hard plucked. The loss in crop may not be at once apparent if the bush concerned be well supplied with reserves. The reduction in leaf area caused by the blight may on occasion stimulate more growth for a time.

It seems probable that the increasing importance of Black rot in the last 20 years may be associated with the difference in the style of plucking. The older method of leaving leaves between flushes left more leaf on the bushes than the system of leaving growth at the beginning of the season and then plucking to the janum. A striking instance of the effect of plucking I

noted on a garden in Cachar. The area concerned had been severely damaged by Black rot in previous years when for various reasons the bushes were plucked very lightly for one season. Casual observation of this area in August, when the Black rot is usually much in evidence, suggested that the disease had disappeared. Closer inspection however showed that the practically every bush was still infected. In the following season, when normal plucking was resumed the damage caused by the Black rot was just as bad as before. Jat and soil appear to have no direct effect on susceptibility to damage from this blight.

Treatment.

As there appears to be little hope that modifications in cultural treatment are likely to have any satisfactory effect on the susceptibility either either to infection or to damage from infection it is necessary to seek direct methods of attacking the fungi concerned.

Experiments under laboratory conditions afford comparatively little information on effects of fungicidal treatment in the field.

The results of experiments on gardens have afforded valuable information There are two fluids of known fungicidal value which are not known to have any adverse effect on the tea leaf and at the same time easy to prepare and cheap enough for general use in tea. These are lime sulphur solution and suspensions of copper. In the case of the latter previous experience has shown that Burgundy mixture is the most generally useful Our experiments have so far been confined to these two fluids.

In order to keep track of the effects of spraying with these fluids it was necessary to keep each individual bush in the treated plots under observation throughout the experiment. This was done by marking the bushes on charts or in special record books.

The general scheme of all the experiments was a latin square of 5 series of 5 replications, making 25 plots. Each plot was ten lines and ten rows of bushes making 100 bushes, less vacancies. Where possible the yield of each plot was recorded and each infected bush marked on a chart or in a ruled book at each round of plucking.

In some experiments all the bushes in the treated series plots were sprayed at intervals and in others only the diseased ones were treated In the latter case the treatment was applied whenever the disease was observed.

A second application was made to the same bushes whenever the fungus appeared to have renewed its activity.

On one garden in Cachar records of individual bushes have been kept for two years. The percentage of those bushes infected at any time in 1935 which remained free from infection throughout 1936 is given below.

1% Burgundy mixture with rosin adhesive, April and August in 1935 and in August in 1936. Lime sulphur in April 1936.	43.4
1% Burgundy mixture without rosin adhesive April and August in 1935 and August in 1936. Lime sulphur solution in April 1936	61.4
1% Burgundy mixture modified formula with rosin adhesive, August in 1935 and 1936. Lime sulphur in April 1935 and 1936.	46.6
Lime sulphur solution, April and August in 1935 and in April and August 1936.	27.8
No treatment except Lime sulphur solution in April 1936.	16.8
Sign. diff. (P=.05)	11.5

'Very few bushes were newly infected but it must be pointed out that in this experiment the uninfected bushes in the first year were less than 15% of the total.

During this season I hope to get reliable figures showing the effect in the second year of treating, whenever necessary, infected bushes only. Where this method has been applied for a number of years on large areas under practical conditions the results are reported to be very satisfactory.

In experiments on two gardens in the Assam Valley the infected bushes only were treated whenever observed throughout the plucking season with the follwing results.

On a garden in Darrang.

Treatments.	Percentage of diseased bushes on 19.10.36.	
4% Burgundy mixture with rosin adhesive	Applied to diseased bushes only.	2.2
3% ,, ,,		2.8
2% ,, ,,		2.5
1% ,, ,,		2.2
Check		23.0
Sign. diff. (P=.05)		5.4

On this garden soda ash was used in the proportions given for crystalline carbonate of soda throughout the experiment. It is difficult for the layman to distinguish soda ash from powdered crystalline carbonate of soda. The fault was due to the wrong description given by the suppliers. The increased alkalinity caused some burning of the young growth at the 3% and 4% strengths and flushing was checked in all cases.

On a garden in Upper Assam.

Treatments.	Percentage of infected bushes on 21.9.36
4% Burgundy mixture with rosin adhesive	4.0
4% Burgundy mixture without rosin adhesive	6.2
1% Burgundy mixture with rosin adhesive	7.8
Lime sulphur solution garden-made	37.6
Check	70 8
Sign. diff. (P= .05)	7.0

The average number of times each infected bush required to be treated was ascertained on the garden by dividing the total number of bushes sprayed by the total number of bushes which become infected at any time during the season.

Treatments.	Number of times Sprayed.	Percentage of apparent recoveries.
4% Burgundy mixture with rosin adhesive	1.22	93.8
4% Burgundy mixture without rosin adhesive	1.27	90.8
1% Burgundy mixture with rosin adhesive	1.24	88.8
Lime sulphur solution garden-made	1.66	51.2
Check	-	1.3
Sign. diff. (P= .05)	-	9.9

The maximum effect was certainly obtained when the spray fluids were applied in the middle of the rainy season. Spraying at any time during the dormant period and in March or April had little permanent effect. This is illustrated by the following observations made on a garden in Upper Assam.

The bushes attacked by Black rot or Thread blight at the end of last year were recorded. These may be taken to be a measure of the degree of infection on the various plots before treatment. The number of bushes on which infection appeared at any time during 1936 to 21-9-36,

were obtained from the record. The differences between the series were not significant.

When the figures are adjusted by the covariance method with the previous year's count, the differences between the series in regard to the number of bushes infected become still smaller. This is shown in the following table.

Series.	Bushes diseased before pruning in 193-.	Bushes on which disease was found at any time in 1936 up to 21-9-36.		Percentage of apparent recoveries.
		Actual.	Adjusted.	
4% Burgundy mixture with rosin adhesive.	361	322	339.0	10.7
4% Burgundy mixture without rosin adhesive.	411	339	335.0	17.5
1% Burgundy mixture with rosin adhesive.	390	350	352.5	10.2
Lime sukphur solution garden-made.	426	385	368.5	9.6
Check.	391	359	360.0	8.1

As there was no significant difference it must be assumed that in this area the treatment applied just after pruning had little permanent effect on the incidence of the Black rot and Thread blight in the following season.

Pending the invention of a more satisfactory cold weather spray fluid it is necessary to carry out the treatment when the bushes are in full leaf. The application to all the bushes at that time is practically impossible. From this point of view it is therefore desirable to treat infected bushes only as soon as they are observed.

It is most important for the garden authorities to keep records of routine work of this kind. If the record of the number of bushes treated in each section in not kept regularly it is more than probable that the work will not be carried out regularly.

There are other factors also which favour the restriction of treatment to such bushes. From our experiments it is apparent that about 50% of the treated bushes may require a second treatment. At least two applications would be necessary were the treatment applied to all the bushes. As at least 300 gallons per acre is required for spraying all the bushes on one acre, 600 gallons in all would be required. No less than 60 lbs. of copper sulphate would thus be applied This amount may have a detrimental effect on the soil. Moreover the amount of sodium carbonate also may on some soils cause indirect damage to the tea.

To apply treatment to infected bushes only requires much less fluid but much better organisation. Even with efficient organisation it is often impossible to undertake the treatment of a whole garden in one year. In such cases the less severely infected areas may be cleared up first and in the meantime lime sulphur solution may be applied to the worst spots, as a palliative only. Then as the numbers of bushes receiving treatment become less on the areas treated with Burgundy mixture this treatment may be extended to large areas until the disease is under control on the whole garden. Control must of course be maintained by continuing the organised treatment but the cost will not be a serious consideration once control has been established.

If Lime sulphur solution only be used it is likely that no permanent improvement will be obtained and the expenditure will not decrease in successive years.

The use of adhesives in Burgundy mixture.

The rosin adhesive tends to reduce the settlement of the blue precipitate and thus renders constant stirring unnecessary. This is important when large quantities of the fluid are being used. On small plots on an experimental scale the problem of keeping the precipitate in suspension is not so apparent. When machines provided with mechanical stirrers are used I doubt whether the addition of the adhesive will be advantageous. The rosin adhesive makes the fluid sticky and on that account tends to interfere with the action of the sprayers. When inefficient sprayers are used it is possible that the adhesive may actually reduce efficiency by making them harder to pump. The application may be uneven on that account. When the fluid with adhesive is applied properly and allowed to dry it is almost

impossible to wash off the deposit. Further experiments are required to ascertain the most effective amount of adhesive. Such experiments however are not likely to yield reliable results unless the machines used are first standardised,

Spraying machinery.

The object of spraying is to cover the surfaces requiring protection with an unbroken film of the fungicidal fluid. The machinery in common use for spraying tea plants leaves much to be desired. The efficiency of the application depends very largely on the fineness of the spray. This in turn is governed by the pressure and the type and condition of the nozzles. The apertures of the nozzles soon become enlarged and if they are not replaced when necessary the drops of fluid become larger and much more fluid is required to cover the surfaces of the leaves and stems with an unbroken film. It is also necessary to have machines which deliver a more or less constant pressure at the nozzle. Most of the cheap sprayers of the syringe type fail to do this. In consequence a considerable percentage of the fluid is wasted when such machines are used. This does not matter so much in the case of a cheap fluid like Lime sulphur solution but it is a very important matter when more expensive fluids require to be applied.

For treating individual bushes a Knapsack machine is desirable. Moreover it is also an advantage in this case to have a self contained machine. The best metal for machines is brass as that is not affected seriously by fluids containing either sulphur or copper.

For applying Lime sulphur solution for red spider and as a palliative for Black rot there is no objection to the use of the cheap syringe type of machine but for treating individual bushes with Burgundy mixture it will surely be more economical to use more efficient apparatus. In regard to nozzles it may be mentioned that a new type of nozzle which emits a fine spray at a low pressure has been put on the market recently. This is called the ACCO spray nozzle and is marketed by the Air Conditioning Corporation Ltd., 8, Esplanade, Mansions, Calcutta. These nozzles are of different sizes. The $\frac{1}{4}$ "size with 1/32" aperture emits 4 gallons per hour at 40 lbs. pressure. It will however deliver a fine spray at much lower pressures. These nozzles need to be threaded specially to fit the connections on the sprayers in use.

We have already ascertained a great deal about Black rot and its treatment but we still require to find a satisfactory spray fluid for use in the cold weather. An experiment is in hand to ascertain the effect of a well known oil spray on Black rot. During my home leave I propose to collect samples of proprietory winter washes likely to be suitable for fungicidal work. Some of these will be tried out next cold weather. Our experience is that winter washes however required considerable skill in their preparation. As badly made oil washes may damage the tea plant it will be desirable to purchase them ready made.

In the discussion that followed Mr. Graham asked about the strength of Lime-sulphur solution used in the experiments on Black Rot. Mr. Tunstall pointed out that the strength should be about four times the strength of that which would prove suitable against red spider. Mr. Luard asked if experiments have been carried out using Mortegg. Mr. Tunstall said that experiments were to be conducted this year in connection with this fungicide which he described as a tar distillate oil emulsion and thought that it might prove more suitable than Burgundy Mixture or lime-sulphur for cold weather spraying since the oil might penetrate the cracks in the wood where the Black rot fungus was located, which was not the case with lime-sulphur or Burgundy mixture in water solutions.

Proceedings of a Meeting held on Friday the 19th February 1937 at 10. 0 a. m. at the Tocklai Experimental Station.

Present : All those present at Thursday's Meeting.

The Chief Scientific officer referred to the circulated proceedings of the previous day's work and asked for any proposed additions or alterations to be handed over to him in writing so that they could be incorporated in the complete account of the Conference which subsequently would be circulated to the members.

He then asked Dr Wight to speak on the problems connected with jat of tea. Dr. Wight addresed the conference as follows.

I do not suppose that I shall take up more than ten or fifteen minutes of your time. What I have to say is more in the nature of provoking a complete discussion than giving a lecture.

I asked the Chief Scientific Officer yesterday if he would mind this morning's programme being altered so as to include something about the jat problem instead of flushing and banjhiness of the tea bush as originally intended. The flushing of the tea bush is a very fascinating subject but it is not of such immediate practical importance as that of jat. Our work on banjhiness and flushing was undertaken to see if the bush could be prevented from going banjhi — we find that whilst the degree of banjhiness can be controlled to some extent, the bush can never be entirely prevented from going banjhi ; but I think that an invaluable part of this work has been the technical information which we and other tea scientific officers are able to make use of in our experimental work.

Anyway. to return to the jat question. The jat of tea grown in a garden or in any section of a garden absolutely sets a limit to the type of tea which can be made. Further, the kind of manufacture which will suit one jat will not necessary suit another — hence the folly of putting out different sections of a garden with different jats. I am referring now to jats which are evidently different — that is, to two or three mixtures of bushes which are obviously two or three different kinds of mixtures. But the whole trouble in taking about jats is that "jat" is simply the name of a concern selling seed and tells us nothing about the kind of mixture that comes from the seed garden. For example, I heard people in the Dooars discussing the merits of different Dooars jats — they are nearly all the same. On the other hand there are Assam baries which profess to be the same as a certain very

popular jat -- they are not the same. A further difficulty lies in any experimental work on jats—it takes us from 6—10 years to get out any results and in the meantime there is no telling what changes may be deliberately brought about in the bari from which we got our seed.

However, I am not very much concerned with jats as such, but with studying every possible variation of the tea bush in an attempt to establish greatly improved seed baries at Tocklai. As to who is to get the financial benefit of these seed baries is matter outside my hands.

As an example of what differences between individual bushes may mean I have here the results of some preliminary experiments which Mr. Cooper and I did last year. Eight bushes were taken at random from one plot at Tocklai and the leaf from each bush was manufactured separately. The teas were marked by the taster for quality and for strength, with the following results (averages for four manufactures of each bush)

Relative Quality.	Relative Strength.	Relative Crop.
9	2	11.5
6	5	10.5
4	7	11.0
3	6	17.0
3	2	9.0
3	0	6.0
2	5	13.0
0	4	14.0

These bushes are all from one "jat" and are differences such as anyone buying seed on the present market may expect.

The tea bush is hopelessly hybridised and it is difficult to find two bushes which are exactly alike. This is because the tea plant in a state of nature is cross fertilised and as this fertilisation has been going on for countless generations the bush could hardly be more genetically mixed. Suppose that we consider flowers on two bushes A and B: flowers on A can fertilise themselves with their own pollen, but if a mixture of pollen A and pollen B be applied to the stigma of flower A then then the pollen from B will in most cases do the trick. Both sets of pollen will germinate but that

from the other flower will germinate more rapidly and will therefore mor often fertilise the flower. In a state of nature where bees are flying fro flower to flower and carrying with them a mixture of pollen it is easy to se that the chances are very much in favour of flowers being cross fertilised an thus all manner of differences are genetically mixed within any one plan The tea flower can pollinate itself : for example, if a single bush is grow in complete isolation, miles away in the jungle, it will still set seed, bu such a bush will not usually set so much seed ; and, the seed which i set will not be so good and is not likely to have such a high percentage germination as that which has been "crossed" from some other bush. This *account which I have given you is based on the work of Russian scientists who are at present far ahead of us in genetical work on tea. The Russians* appear to give generous financial support to their scientific work and we here are making use of their results.

The fact that tea is so completely hybridised makes vegetative propagation of great value and the work which Tunstall has been doing along these lines is important. Suppose that we have a thousand trees in a seed bari : as you know, different trees will not produce identically the same pullies (seedlings) — this is because they are already many times hybridised and each tree is probably a little different from every other tree — and we may regard each tree as producing a slightly different mixture of pullies. If seed is collected from each tree individually and a thousand small nurseries put out, each nursery will contain a mixture of pullies as you know, but we should probably have one thousand different mixtures each containing more or less of this or that type. If, on the other hand, we grow one thousand cuttings from one particular bush — say the "nine marks for quality" bush of our experiment — then each bush will be the same as every other bush — they will in fact be what we call a clone and will all be part of the same bush ; and a seed bari put out by this means would contain not one thousand different bushes, but one bush only ; and would give not a thousand different mixtures of pullies but one mixture only. Whilst the result would still be a mixture of pullies we should get a much lesser mixture ; and though methods of vegetative propagation are not yet sufficiently reliable for putting out large sections of tea — one sometimes gets 80 - 90 % success and sometimes all are a failure — yet leaves and buds are cheap enough, and as there is no great urgency attached to establishing a seed bari, vegetative propagation is a practical method. There is

however, a snag in this scheme : to return to the flowers A and B — if B be removed and A forced to pollinate itself, then the crop of seed will neither be so great nor so good : and our seed bari put out by vegetative propagation will be forced to pollinate itself because it all consists of one bush — we shall get less seed and not so many pullies from this seed, and thus the greater uniformity is not a commercial proposition. There is only one way out of this difficulty and that is to take two different but desirable bushes (say A and B) and by cuttings from them establish two clones and interplant the bari with A and B alternately. This will give us a mixture of seedlings from two bushes, but this will be better than the mixture of seedlings from a thousand bushes.

Our programme of work for the present year is to manufacture the leaf separately from about two hundred different bushes with five repeats of each manufacture. We shall start with the best jat we have in Tocklai and take our two hundred bushes from that. We shall then be able to pick out, say, the ten best bushes. Of these ten bushes, a large number of different pairs will be possible, for example AB, AC, AE, and so on, and we shall have to grow every possible pair of bushes separately in isolation. It will of course, be possible by means of cuttings to repeat bush A, or any other of the ten selected bushes, as many times as we require. The pairs of bushes will have to be isolated from each other by jungle and will be left to pollinate one another naturally as they would do in a seed bari. The seed from each pair of bushes will then have to be collected and we shall see which pair of bushes pollinate each other most successfully and produce the best crop of seed. The seedlings will have to be examined for uniformity and a small manufacture made from the seedlings to see that the quality is what we want. There is no guarantee that seedlings will ever be the same as the bush from which the seed was gathered: a good looking bush giving good quality may throw very undesirable seedings, whilst an apparently undesirable mother bush may give just what is wanted in the nursery, so that one should select a seed bearer, or a pair of seed bearers, on the characters of the seedlings which they give and not on the characters of the bush itself. Thus one might say "Take any ten bushes and put them out in pairs in isolation and do not go to the trouble and expense of a preliminary manufacture of two hundred bushes" — there is a certain amount of truth in this, but nevertheless I think that it will be a move in the right direction and that we shall increase our chances of getting what we want

by commencing with the most desirable bushes that we can find. Having finally decided on the best pair of parents, say A & F, A & F would each be multipled to several thousands of bushes and baries put out with A and F interplanted. Actually, one would retain several pairs of parents, because one pair would be valuable for one characteristic and another pair for another characteristic. Work such as I have outlined is simply selection of existing material and making the best compromise of a large number of variable factors with the certainty of making some improvement within a reasonable period of time — say ten to fifteen years.

Another line of advance is genetical work — pucca plant breeding. The plant breeder can cause almost any desired character to come true from seed. When one buys a certain variety of corn or wheat, one expects all the plants to be true to type and not mixed: the same thing can be done for tea. In the case of wheat, it may take, say, ten years to cause a particular character to breed true from seed, but in the case of tea where we have to wait six to ten years before we can get a reasonable crop from seed, the same selection might take from eighty to one hundred years. This seems a long time but there is no reason why the work should not be carried on continuously for Tocklai will presumably exist as long as the tea industry. The work is not expensive, time and patience being the main requisites: on our Tocklai seed bari are now developing our first artificially pollinated flowers in this scheme of work.

A third possibility lies in vegetative propagation though few people regard this as more than a fantastic and impracticable dream. I have mentioned that growing from cuttings, though probably suitable for laying out small seed baries and the like, is not yet sufficiently certain for large sections of tea. But, supposing that we could make quite certain of rooting 80—90%- or I see no reason why we should not reach 99%- of our buds or of our twigs, and that within a reasonable period of time: then there would be no difficulty whatever in planting large areas of tea in which every bush is alike, for example, all 9 mark bushes, and this would further do away with all the expense and time involved in the selection and establishment of better seed baries. True, a man is required to attend to cuttings, and propagating frames would probably be necessary, but seed at Rs. 150/- per maund goes a long way towards paying for propagating frames and tea leaves do not cost

very much. It may be quite possible to find some chemical "dope" with which we can treat our cuttings and so make sure of successful rooting. Anyway, however fantastic this possibility may seem, it is one which should be investigated to the fullest extent of our abilities.

This, gentlemen, is all that I have to say. I hope that representatives from the different districts will give us their views on these problems because the question of suitability to local conditions and also to the financial position of the garden, is very important.

In the discussion which followed Mr. Luard raised the question of budding methods of propagation which were referred to in the Engledow Commission Report and Dr. Wight said that this method was being tried in one seed bari in North East India.

Mr. Carpenter mentioned that he had seen a seedbari in Java grown from bud grafting. In this seedbari a light leafed Assam variety (Dr. Watt's seed) had been grafted on to a dark-leafed stock. The seedbari was very even and care had been taken to suppress the growth of suckers from the stock. Bud grafting methods are being extended to the case of plucked bushes in order to improve quality but success was at present problematical.

Mr. Carpenter described the small scale manufacturing methods used for getting samples of tea from individual bushes. He referred to the sources of error in the method used in the experiments and said that with the installation of a specially designed small C.T.C. machine we could expect considerable increase in accuracy as well as an increase in the number of experiments which could be made. He then referred to the question of propagation by cutting and said that there was hope of obtaining success with this method as a result of further investigations possible with the use of chemical substances which are known to stimulate growth and callus formation.

He then referred to the deterioration which had taken place in some long established seedbaries even in those cases where it was fairly certain that this deterioration was not due to undesirable hybridisation.

Mr. Benton addressed the Meeting with the following remarks on the distribution of Bacteria occurring in different stages of tea manufacture :—

"Gentlemen

The study of the bacterial influence on tea manufacture has attracted a great deal of attention of recent years, and has provoked as much controversy as Mr Cooper's results on cultivation. I think I may say that in every large tea district there are gardens which have benefitted by bacterial control measures, yet there are Managers who do not believe in the bacterial theory. I want first to call your attention to two basic facts of bacterial activity — bacteria cannot develop without suitable food and they are destructive organisms, in other words their development results in the breaking down of their food supply to simpler substances.

A second point I should like to make is that the conditions under which bacteria are at work frequently determines the results of their activity. Thus when the fermentatation of maize meal was utilised in the war for the production of acetone, large amount of which was required for the manufacture of explosives, fermentation was conducted in cylindrical vessels and the angle at which these vessels was tilted was found to be an important factor in obtaining the maximum yield of acetone. When laid flat or stood on end, the yield of acetone was low, while a maximum yield was obtained when the fermentation vessel was tilted at, I think, 67°. In other words a slight change in the amount of aeration profoundly altered the reaction. It is probable that we shall find that the conditions under which they work will determine the effect of bacteria on fermenting leaf, and it is possible that organisms which are normally harmful may be beneficial in special circumstances. The whole subject requires complete investigation. In the meantime I propose in the short time at my disposal to gtve you a brief outline of the work we have so far accomplished on the origin of bacterial infection. This subject has been under study for the past seven years and has proved far more complicated than was first expected ; in fact it is only within the last two years that some order began to emerge from a mass of accumulated data. The two factors which have contributed most to this result are the development of a new culture medium for studying the bacteria of the leaf and the factory, and the application of statistical methods in following bacterial changes during manufacture.

That considerable progress has been made is shown by the fact that five years ago 500,000 bacteria per gram was considered to be the normal minimum in fermenting leaf, while in the past year it has been possible to reduce the count to 5,000 bacteria per gram or less, in commercial factories. It would be premature to state that all the origins of bacterial infection have been determined – as recently as last year an entirely unsupected source of infection was discovered. I refer to the rapid development which occurs when leaf, particularly wet leaf, is allowed to heat up before withering, and I have no doubt that other sources of infection exist, but some of the more common factors influencing bacterial development have now been established.

Many different species of bacteria are found on the leaf and in the factory, and our knowledge will not be complete until the effect of all, under varying conditions of manufacture, is known. For the present we have classified them as follows :—

(1) Tea bacteria. Chromogenic types which will not grow on Brom - thymol blue medium.

(2) "Blue" types. Non - chromogenic types which give blue colonies on B. T. B medium. Their effect on fermenting tea is unknown.

(3) Orange or "O" types. Non chromogenic types which give orange colonies on B. T. B. medium. Members of this group are known to produce soft dull liquors and dull infused leaf.

(4) Sour types. Non chromogenic types, giving blue colonies on B. T. B. medium, and capable of producing sour teas. Little is known of this group.

The first three groups occur naturally on the leaf. The origin of group 4 is unknown. The distribution on the shoot is as follows : —

	Tea bacteria	Blue and O types.
Bud	115,000,000	4,600,000
1st leaf	14,600,000	720,000
2nd leaf.	5,100,000	100,000

The distribution suggests that the bacteria are breeding within the folds of the bud. The relative numbers of Blue and "orange" types vary considerably, but the Blue types are nearly always in excess :—

Blue	190,000
Orange	14,100

A seasonal variation is also found, the orange types increasing in mid-season.

The behaviour of the Blue types in withering has not been closely studied as yet, and for the rest of my talk I shall be referring to Orange types only, except in the question of fermentation.

When fresh cool dry leaf is withered some increase in the orange types may taken place, e. g.

Before withering	1,580 per gram
After withering	19,680 ,, ,,

This, rise may be avoidable, but is probably immaterial. Two factors are known however, which increase bacterial develoment to a dangerous extent. These are ;-

(1) Overheating leaf after plucking, especially when wet.
(2) Wet leaf remaining wet on the chungs.

1 (a) Dry leaf allowed to heat.

Fresh leaf	1580	
4½ hrs in basket	Loose	Pressed.
Withered leaf	19,680	419,000

(b) Wet leaf allowed to heat.

Fresh leaf	4,300	
4½ hrs in basket	Loose	Pressed.
Withered leaf	390,000	12,260,000

2. Wet leaf

	Allowed to dry	Remaining wet.
Fresh leaf	730	730
Withered	250,000	13,200,000

It will be noted bacterial increase in withering is likely to occur when the leaf is wet and particular care is necessary to prevent wet leaf becoming heated in the baskets.

These facts may account for the success of "kutcha leaf" manufacture in the Dooars. In Assam there are few days when a wither of some sort

is obtained, and surface moisture rarely remains on the leaf for more than a few hours. In the Dooars and Terai, rain is frequently experienced for days at a time, and high bacterial counts are therefore to be expected in leaf which has been lying wet on the withering racks. If leaf fresh from the field is manufactured without withering, fermentation is concluded before the bacteria have had time to develop, and soft dull teas are thereby avoided.

If a good wither is secured and the leaf has been kept cool, the bacterial count should be fairly low when it enters the factory proper. At this point I propose to introduce again the question of the Blue types.

In experimental work carried out some years back with pure tea tannin we conceived the idea that unoxidised tannin might be toxic to bacteria. This is born out by results obtained in manufacture.

Blue types.

	1.	2.
Withered	430,000	4,670,000
Minced	nil	26,000
Fermented 1 hr.	-	1,400
2 hrs.	-	nil.

Although the bacteria are killed and cannot infect the machinery, it does not follow that their enzymes are incapable of affecting the fermenting leaf. Further study is required on this point.

Orange types.

	1.	2.
Withered	50,760	20,300
Minced	3,410	1,528

Since the Blue types are normally destroyed when juice is expressed and the orange types are reduced considerably, counts of 500,000 - 1,000,000 per gram which were once considered normal must be regarded as abnormal, and indicative of faulty handling or withering, or of infection in the factory.

Little increase takes place during the normal period of manufacture but if the fermentation time is extended, rapid development commences :—

	(1.)	(2.)
Minced	3,150	4,964
Fermented 2 hours	2,465	4,400
5 hours	79,800	29,892

Leaf particles and juice adhering to machinery and floor surfaces undergo prolonged fermentation and as fermentation proceeds the rate of bacterial development increases :

Fermented 3 hours	3,530,000
6 „	10,000,000
9 „	249,000,000
12 „	2,600,000,000
24 „	11.300,000,000

Under normal conditions, rolled leaf appears to be capable of supporting some 10,000,000,000 bacteria per gram and at the temperatures commonly found during the season on the Plains this figure is usually reached within 24 hours. These bacteria unless removed by cleaning or destroyed by flaming rapidly infect the fresh leaf brought into the factory for the following day's manufacture and there is reason to believe that they are less susceptible to the toxic effect of freshly expressed juice.

Mr. Irving asked what was considered to be the best type of fermenting floor. Mr. Benton replied that a smooth hard surface which could easily be kept perfectly clean and free from tea juice was considered satisfactory. Mr. Irving asked for an explanation of why new cement floors gave poor quality teas when first used. Mr. Benton explained that it was most probably due to the presence of lime in the cement and suggested that a new floor should be thoroughly soaked out by flooding with water, changed daily, for a period of at least 14 days and then polishing with carborundum bricks before the floor be used for fermentation. Mr. Irving asked whether the use of rolled kutcha leaf and tea juice as a means of curing a new cement floor was satisfactory and Mr. Benton thought that it would have the same effect as water curing providing all traces of tea juice were removed from the floor before it was used. The action of the tea juice was to remove the lime from the surface of the cement.

Mr. Graham referred to the use of water containing lime for washing down fermenting floors and said that it had been observed that it had harmful effects.

Mr. Harrison referred to the confirmatory results obtained in Ceylon on the changes in bacterial content of the leaf during manufacture.

Mr. Carpenter asked Mr. Benton to explain the 12-hour fermentation test for bacterial infection in a factory. Mr Benton described the test as follows :—

> A handful of leaf from a roll at the end of the day's manufacture is placed in a glazed dish and covered. After 12 hours the leaf should have a sweet smell, bright colour and should not be slimy to the touch. If sour, dull and slimy there is indication of serious infection. An infusion after 12 hours should also be made. It should be bright in cup colour and infusion. The liquor should not be cloudy and it should show a bright golden colour with milk.

Mr. Harrison addressed the conference on certain aspects of the Department's experiments on the quality of tea, as follows :—

"The measurement of the effect of various factors influencing the value of tea, which is of the greatest practical importance to the industry, has for some years been the chief work of the Chemical Department, and much help, advice and criticism has been received from different sources. I wish to discuss the scope of the work, its difficulties and the methods we employ in overcoming them.

The first consideration is the scope of the work, involving a review of all the factors which may conceivably affect the value of a tea. I divide these factors into three groups.

(1) Pre-manufacture influences. These include all those factors operative up to the point when the green leaf is landed at the withering house. They include jat, (or variety of plant), soil type and condition, styles of pruning employed, manuring, degree of shading, climatic conditions and many other factors known and as yet unknown.

(2) Manufacturing conditions. These include all variations in the process of converting green leaf to black tea ; variations in condition of the atmosphere in the factory and withering house, variation in types of machinery used, and so on. These factors are referred to in more detail in "Methods for Conducting Factory Experiments" I. T. A. Q. J. 1927, part IV. page 193.

(3) Post manufacture influences. After the tea has been packed it may still undergo considerable change under different conditions of packing and storage ; temperature and moisture content of the tea probably playing a major part.

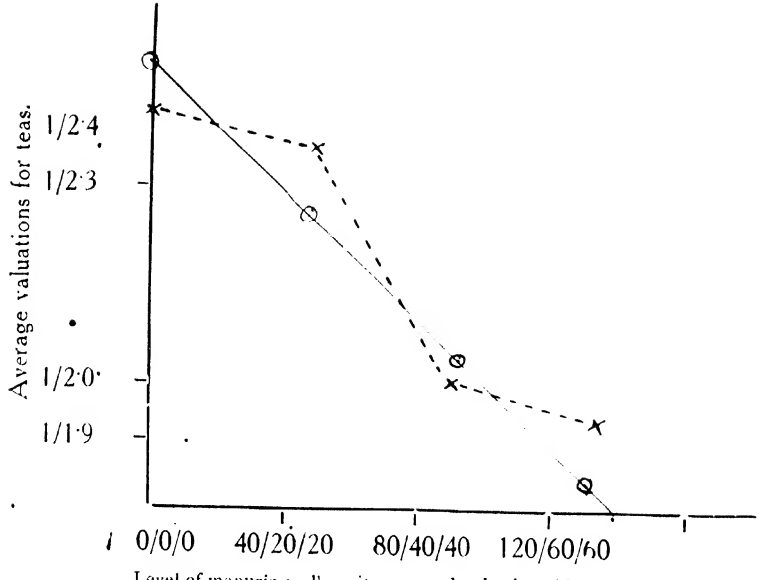
With the limited resources at our disposal it has been impossible to attempt simultaneously a full study of all three groups of factors affecting tea value. We have therefore, commenced with the pre-manufacture factors and claim that much progress has been made, and valuable information obtained. The main reason for our choice is that the machinery and apparatus at our disposal does not permit of experiments on manufacturing processes being carried out in such a manner that their results can be applied with confidence to actual practice On the other hand, our varied selection of plots at Borbhetta provides valuable material for comparative experiments on the effect of various treatments in the field. Furthermore

work on manufacture is being done in Ceylon where there is a full scale experimental factory, and while it is clearly realised that the results cannot be applied wholesale to North East India, they will give us useful lines to work on when we are in a position to carry out similar work ourselves.

One criticism occasionally made is that our experiments are too complex. Experiments involving the effect of various factors on yield or quality of an agricultural product may be regarded as a series of questions put to Nature for answer. It might be thought, and was thought until comparatively recently, that the simpler the experiment, the more the likelihood of getting a definite answer. In this connection, the following remarks made by R. A. Fisher in 1926 are apposite. "No aphorism is more frequently repeated in connection with field trials than that we must ask Nature few questions, or ideally, one question at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logically and carefully thought out questionnaire ; indeed, if we ask her a single question she will often refuse to answer it until some other topic has been discussed".

The soundness of Fisher's view has been borne out many times in results from some of our earlier experiments on manufacture. We sought some years ago, to find out what degree of wither gave us the best teas, and found that we could obtain no definite answer to our question. In one experiment, a high wither gave best results, while in another it was the low wither which came out best. Had we performed a complex experiment, introducing different temperatures and times for withering, different speeds and pressures in rolling, different thickness and times of fermentation we should have obtained a clear picture of the inter-dependence of all these factors, and seen why on certain occasions the high wither scored and why on others, the low.

By making an experiment too simple, it is possible, even, that misleading results may be obtained In 1935 we studied the effect of a complete inorganic manure in different quantities on tea quality. Valuations obtained showed the results indicated on the graph below : —



The crosses indicate the actual valuations (averages of 8 trials). It appears that there is no appreciable loss in quality from the small dose of manure; a considerable loss when the dose is doubled, and little further loss from larger doses. Statisticians are able to tell us however that this is not the case. The true story is shown by the straight line on which the 4 circles indicate the most probable valuations, since none of the actual valuations is sufficiently removed from the straight line to be outside the experimental error, while they are sufficiently near to it for the straight line to be accepted as representing the truth. The straight line shows a steady decline in value as the manuring is increased, about 0.17d. for each 40 lbs increase in nitrogen.

Had we confined our attention to the simple comparison of no manure and the small dose, the only conclusion we could have come to is that the manuring had made no difference.

Unfortunately practical considerations limit the degree of complication to a great extent. In our own experiments we are able to deal with 8 variations of treatment in any one experiment, and only this number by repeating the experiment at least 8 times, preferably more.

Thus if we wish to study the effect of manuring on quality we can study for example the effect of 4 manuring treatments on two jats of tea. Results might. for example, indicate a big loss in quality from heavy manuring on good jat tea. but little loss on poor jat, information of far more practical value than merely the statement that "a loss in quality has resulted from heavy manuring"

It was strongly recommended by the Engledow Commission that there should be some common basis for comparison of the different tea characteristics, similar to that in use by the Thee Expert Bureau in Java. where a standard glossary of terms is in use. We have tried to introduce a system of marks for the different characteristics but have so far not been successful.

Such a proceedure would add greatly to the information derived from our experiments, but would also add greatly to the work, already very considerable which the tasters are doing for us. Actually, valuations have proved extraordinarily accurate, far more so than is generally realised. We must however still have valuations based on the current market, otherwise there is no means of balancing the cost of a certain treatment against its effect on the commercial value of the tea made,—the final criterion from the practical man's point of view. After all it is of little value to know that a certain degree of coarse plucking gives a tea which is, say, less brisk, with less quality etc. than a fine plucked tea, unless we know what this difference means in annas or pence, and can balance up the drop in price against the lower cost of production.

The use of statistics in connection with the results of these experiments has perhaps been regarded with suspicion in some quarters. We have been accused of submitting reports to a "too microscopic analysis" The "microscopic analysis" complained of is necessary because of the many outside factors other than the ones we are investigating, which may affect the value of the tea. Experiments are of course designed to eliminate as many of these outside factors as possible, but there are many which cannot be removed, and it is the magnitude of these which the "microscopic analysis" determines, enabling us to separate their influence from that of the factor whose effect we are measuring. One example of an interfering factor which we cannot eliminate, and which must be separated from the factor under investigation by statistical analysis is that of the variation between

judgment of tasters. It is not to be expected that all tasters, or even an two tasters, will place the same price difference on a pair of sample sent to them. Market preferences alone will cause variations in opinion. A mistake might occur in preparation of the sample for tasting and so on Take for example the following two sets of valuations—the figures are fictitious of course and perhaps somewhat exaggerated for the purpose o illustration.

							Average
(1) Sample A.	10	11	10	9	9	8	9.5
„ B.	9	10	10	8	8	$7\frac{1}{2}$	8.7

Sample A is placed better than B by 5 tasters out of 6 and once placed equal. It is obviously better than B.

							Average
(2) Sample A.	9	9	10	12	7	10	9.5
„ B.	9	10	10	8	8	$7\frac{1}{2}$	8.75

Sample A is made much better than B by two tasters, equal by two, and worse by two. The difference in average although of the same magnitude as in case (1), cannot be considered on the evidence available, to be a real one, since the variation of opinion is so great among the 6 valuers.

Statistical science comes to our help in this connection in enabling us to determine, from the consistency of individual observations, what the chances are that any difference in the averages of these valuations is a real one.

The terms "real and significant" used frequently in our reports, need some explanation, and are used here in a statistical sense. When dealing in exact measurement, as for example the length of a piece of string, or the height of the barometer, one measurement with a standard measuring appliance may be all that is necessary. But, even in apparently simple operations such as these there are sources of error, and if very exact results are required, several determinations by several different observers may be necessary. When, however, we are dealing with a measurement so elusive as that of the effect of different factors on tea value, and using so delicate a measuring instrument as the palate of the taster, replication of observations and observers is obviously of far greater importance since errors are far more liable to occur throughout the course of the experiment.

The purpose of a statistical analysis is to determine from a number of repeats of an experiment, what the odds are in favour of any difference in the average results, being really due to the difference in treatment and not to chance. No agricultural experiment is nowadays convincing unless it is capable of being subjected to a statistical analysis, and it is generally accepted that odds of 19 to 1 on. are required for a result to be significant. In other words the same result must be considered capable of occuring by chance only once in 20 times. The reason for the many conflicting results of old experiments, as for example those referred to by Mr. Cooper in his address on organic matter and composts, was that they were not capable of such statistical examination. Results due to differences in soils were confused with those due to treatments

I have tried to show the difficulties in carrying out experiments of this nature and the great risk of false conclusions being drawn from inadequately planned trials, in order to convince you that such experiments are extremely hard to do under ordinary factory conditions. *Anyone therefore desiring to carry out experiments in his own factory is very earnestly asked to consult us as to the best way of conducting them so that results shall be of real value.*

Among the results of practical importance obtained so far from our experiments, the following may be mentioned.

(1) Quality value of different jats Four jats, two light leaf Assam, one dark leaf Burma type, and one China jat were manufactured during three plucking seasons. The characteristics of leaf and liquors of the teas of these jats were investigated and their relative valuations on the three season's markets were obtained. It is shown that light leaf jats produce liquors having more quality and flavour than dark leaf jats The former also produce much more tippy teas All light leaf jats do not however produce equal quality. Dark leaf jats give strong liquoring teas without marked quality. The teas are black in appearance and lacking in tip. China jat gives, when grown under plains conditions, thin liquoring teas, often with flavour, which is however generally insufficient to offset the thinness of liquor.

(2) Pruning. Annually pruned bushes have produced better tea than that from unpruned bushes, or from bushes pruned on 2-year old wood. The superiority of annually pruned tea is greatest in the early part of the

season and decreases as the season progresses, being least marked in th autumnal period. Many more experiments on pruning are required. The effect of cleaning out of banjhi and weak shoots, the effect of pruning at different times during the year, and the effect of medium pruning, on the character of leaf and liquors of teas, must be investigated.

(3). Plucking. The effect of different degrees of fine and coarse plucking, of different degrees of hardness of plucking and of rains skiffing has been investigated. Results of these experiments have been published in a pamphlet on the Quality of Tea, and in Annual Reports.

(4) Manuring.

1. Effect of complete inorganic fertiliser in different quantities and in single and divided doses has been studied. Very slight but significant loss in quality from manuring with mixtures supplying 80 lbs. or more nitrogen has been obtained.

2. A comparison of the effects of organic fertilisers (both of animal and vegetable origin), and purely inorganic manures was made and it was shown that none of the various manures, applied in quantities to give 60 lbs. nitrogen per acre had any measurable effect on the chara cteristics of the leaf or liquors of the made teas.

3. Potash manures have been shown to have a slight adverse effect on the liquors of the made tea, while phosphoric acid was shown to have a very slight (and doubtful) effect in improving quality.

(5) Experiments on different temperatures, times, airspeeds and thickness of spread of leaf, in firing have been carried out and valuable information for use in future experiments on the practical scale has been obtained.

Mr. Irving asked if any experiment had been done with mixed, light and dark-leafed varieties. Mr. Harrison replied that there had not. Mr Carpenter said that it would be a long time before we could get a working system of valuing the different characteristics of teas similar to that employed in Java He further pointed out that a panel of tasters suggested by the Engledow Commission would not prove satisfactory. It

was of great importance to have individual opinions of the various tasters concerned in the valuing of the teas. He also pointed out the importance of eliminating personal bias. He referred to the fact that the members of the Engledow Commission had been particularly impressed by the results of the experiment on Borbhetta where organic manures of both animal and vegetable origin are compared with purely inorganic fertilisers. He also mentioned that a large amount of data had been collected bearing on the value of organic matter in soils in different provinces all over India. This data has been examined by the Imperial Council of Agricultural Research and there was little information in it mainly due to the fact that in so many cases experiments were badly designed. Steps are now taken to see that all experiments carried out under the auspices of the Imperial Council of Agricultural Research are properly designed so as to be capable of full statistical investigation.

Mr. Carpenter requested that anyone wishing to carry out any factory or field experiment should first consult Tocklai in regard to its design.

Proceedings of a Meeting held on Saturday the 20th. February 1937 at 2. 0 p. m. at the Tocklai Experimental Station.

Present : All those present at the previous two meetings.

The Chief Scientific Officer outlined the Department's Programme of Work for 1937 as follows :—

"In explaining to you the Programme of Work for 1937 I think it would be best if I deal with each Branch separately.

The Chemical Branch —This year Mr. Cooper will be proceeding on seven months leave.

We have already carried out manufacturing experiments to ascertain the effect upon quality of manuring with nitrogen, phosphate and potash and with inorganic and organic manures in different forms, also the effect of jat using light-leafed, a dark-leafed and a China hybrid type. Experiments have also been conducted with regard to plucking. We have also investigated the quality of tea made from different jats of tea annually and biennially pruned. This year we propose to continue such investigations on quality by manufacturing weekly, leaf from different styles of plucking, that is to say, from different initial lengths of growth 4", 6" and 8", both plucking to the janum and leaving a leaf at the second flush. Also by plucking the bushes severely i. e. 4" and the janum up to the end of July, leaving them unplucked during August, then skiffing so as to leave one full leaf and then pluckiug to the janum ; and in another case plucking in exactly the same manner but skiffing so as to leave 3 leaves instead of one leaf. This should show us the effect of severity of plucking and also what effects sparing the bushes later in the season have upon quality.

A weekly experiment will also be carried out to ascertain the effect of time of pruning and cleaning out on quality. Manufactures will be from bushes annually clean pruned in December, July and February, annually cut across in December and from tea biennially clean pruned in April, cut across in April, clean-pruned in June and clean pruned in September/ October. It is of particular importance to know the effect of such alteration in time of pruning upon the teas made during second flush and autumnal periods. In conjunction with these manufacturing experiments, analyses of the fresh leaf from the plots supplying the leaf from the plucking experiments will be made in order to see how the composition of the leaf varies with the different plucking and to correlate this, if possible,

with the different quality of the tea made. In the investigation of jats it was noticed that different jats, and indeed different bushes of the same jat, behave very differently during fermentation and a study of the relative rates of fermentation will be made on about 12 bushes this year.

In regard to soil chemistry, soil acidity will be determined in ordinary routine practice on samples received from various gardens and from the Borbhetta and Tocklai plots.

The determinations of organic matter and soil nitrates will be made in connection with compost experiments at this Experimental Station.

The Botanical Branch :—This branch will carry out a greatly enlarged programme to investigate the variation in quality of different bushes within a jat. It is hoped that manufactures will be carried out during 4 days of the week using leaf from 20 bushes daily thus allowing manufacture to be made on 80 bushes per week. This will be replicated over 10 weeks. It is hoped that two such series will be possible during the year which will give data for 160 bushes. For this experiment we shall use a light-leafed Assam tea known as a jat to give good quality. Whether it will be possible to carry out this experiment fully, will depend very largely upon the date on which we receive the miniature C. T. C. Machine that has been ordered.

In addition to this the Botanical Branch will also investigate the growth of the flowers on a tea seed tree and the time of determination of the flower buds.

This will keep the staff of the Botanical Branch very fully occupied.

The Mycological Branch—Mr. Tunstall will be on seven months leave this year and consequently the work of this laboratory will largely be confined to routine work. Investigation of the Eel-worm which has been causing damage to tea cuttings will be continued. It is hoped that some work may be done towards finding the practical method for estimating reserves in tea branches as opposed to roots. Investigation of prevention of disease attacking wounds will be continued and a further investigation of various winter washes in use in Europe will be made with the object of finding a suitable fluid for application during our dry cold weather. The experiments for the control of Black Rot will be continued and if possible supplemented.

The Bacteriological Branch—will much enlarge the experiment dealing with the effect of temperature upon fermenting mal. I have already pointed out that leaf that becomes hot in the withering baskets rapidly develops bacteria. This will be further investigated by means of factory experiments if time is available. Experiment will also be carried out to ascertain the relative values of clean cement, polished aluminium and aluminium with a film of tea juice in regard to development of bacteria and the quality of the tea.

The Engledow Commission particularly emphasised the investigation of moulds in finished tea. This has received attention during the past year in the direction of establishing a satisfactory technique. The investigation will be continued and a preliminary survey of mould infection in tea will be attempted.

The Field Work — Our programme does not include any new experiment although we shall expect to get results from comparatively new experiments started last year and in previous years that have not yet been going for long enough to have given results up to date. Such results will begin to accumulate next year. We hope for instance to obtain results with regard to the value of composts.

The other field experiments will continue.

At the present time a number of gardens have laid out experimental field plots and last year these were used for determining the relative values of the plots when none of them received any treatment. This year the various plots will receive differential treatments and we shall hope by the end of the year to have accumulated some data in regard to the value of the same manure in different districts and on different soils. Our experiments have already shown a considerable difference in response to manure here and at Tulsipara.

I might add that such field experimental work is in the nature of preparing for the Advisory Officers, who will find that they do not have to start right at the very beginning but that experiments are already in progress.

Touring — It is impossible with our restricted staff to undertake touring We are still short of 2 European Officers and 17 Indians.

I wish to resume regular touring so soon as possible and I have already said that the appointment of one Chemist to fill the vacancy made by Dr. Harler leaving, will allow of this being done. The man will be concerned entirely with the work of the Chemical Branch and it will hence be unnecessary for him to have special training other than that he has already received as a Chemist. This will allow both Messrs. Cooper and Harrison to tour. The Committee of the Indian Tea Association Calcutta and the Sub Committee of the London Indian Tea Association have agreed to the proposal and I hope it will soon be implemented, although this was not a direct recommendation of the Engledow Commission who laid special stress upon the Local Advisory Officers. It will be some years before these Advisory Officers will be settled in your districts and it will be a much longer time before you will be prepared to accept their recommendations.

I hope therefore that you will join with me in pressing for this one man to be sent out early next cold weather.

Mr. Carpenter then called for comments from the different delegates both in regard to the work done in the past year and the programme or work for 1937.

Mr. Boyle proposed that the agenda for the next Conference should be sent to the delegates sometime before the Conference so that they could circularise their district for suggestions which could be placed before the Conference. Mr. Carpenter replied that he proposed to do this before the next Conference.

Mr. Luard suggested that the earliest opportunity should be taken to obtain the services of an additional Chemist so that regular touring programmes could be resumed. Mr. Carpenter mentioned that it might be possible to get a man out in October and that Mr. Cooper, while on leave this year, would be able to assist in his selection.

Mr. Graham had three points to bring up—

1. The question of vegetative propagation. This the Department was already dealing with.

2. The possibility of determining the different characteristics of tea liquors resulting from different treatments and processes as opposed to comparative valuations alone There was a considerable discussion on

this point. Mr. Carpenter emphasised the fact that the Department had been trying to get tasters to value along these lines but that it had so far not met with success In this connection Mr. Carpenter asked Mr. Cooper to read a memorandum which had been sent from Tocklai to several tasters outlining a scheme by which the various tea characteristics could be evaluated :

Mr. Cooper read as follows : —

Subj. Comparison of Experimental Teas.

"The only definition of "quality" of any practical use with regard to any article of commerce is "value on the market." Hence we have hitherto asked tasters to assign comparative values in annas or pence to the experimental teas which they have been so good as to taste for us.

Reports, as well as valuations, have been asked for and have been given by most tasters From these reports (some have been very clear and good) it has been possible to see why a particular treatment has produced an average valuation above or below the mean of all samples tasted in the particular experiment.

While the information obtained by these methods is very valuable, suggestions have been made, by the Engledow Commission, and independently by Messrs. J. Thomas & Co, that the utility of the experiments might be increased if in addition to valuations, particular "characters', of each tea were directly compared by the tasters.

The valuation assigned represents the tasters opinion of the manner in which the summation of all these "characters" (good or bad) would affect the market. Thus it occurs, for example, that two tasters agree that sample A has more "strength" but less "quality" than sample B, but while one taster thinks that the lack of strength out weighs the quality of sample B, the other taster may hold the opposite opinion, with the result that two tasters really in agreement, may disagree in valuations.

Then, too, the market has of recent years shown such a lack of discrimination that tasters have found it very difficult to indicate real difference between teas by a difference in market value, where they would find little difficulty in placing the teas in order of e. g. "strength," "colour," "briskness" or "quality.,"

Further : valuations compare teas only for the state of the market at the time of valuation, while differences in "strength" etc. are independent of the market, and records of such differences have a more permanent value.

The fact that it is impracticable for the purpose of our trials to sort teas, so that tasters are asked to value "grades" outside their normal experience, also introduces difficulties in valuation since the dry leaf is a big factor affecting valuations. Difficulties connected with the dry leaf do not affect direct comparisons of liquor characters or of infused leaf.

We had hesitated to ask tasters to add to their already heavy unpaid work on behalf of the industry, but now that the suggestion has come from a broker we place it before all co-operating tasters with a request for their opinions on the scheme in general, and for any amendments which they may suggest.

The suggestion is that each tea might be assigned to one of a number of previously defined classes with regard to

1. Tip
2. Colour of dry leaf

   Considerations of other leaf characters hardly arise in the case of unsorted teas. In the case of our samples plucking, rolling, and firing are constant. "Make" therefore depends only on the wither which is not completely within our control, and any great difference observed between samples in "make" is probably an accident of manufacture. When we make withering experiments, "make" must be considered.
3. Infused leaf.
4. Strenght of liquors.
5. Colour of liquors.
6. Quality of liquors.
7. Briskness of liquors.

The question of flavour hardly arises with regard to Tocklai teas, and so far as it does arise possibly may be considered as affecting "quality" rather than as a distinct character. On this point the opinion of tasters is desired. We observe that when 'flavour" (e. g in a second flush tea) is noticed by some tasters, other tasters will refer to the same tea as possessing "quality".

"Pungency" possibly may be considered to be a high degree of "briskness". We are aware that tasters have not reached agreement on this point ; but possibly it may be agreed that a "pungent" tea can never be "soft", while if the tea is "pungent" its briskness hardly needs additional comment. If "briskness" and "pungency" are different characters, at any rate they appear somewhat similar in kind, and it is desirable to avoid the introduction of another basis of classification. We shall value the opinions of tasters on this point also.

The classes suggested for consideration with regard to each "character" are :—

Quality of tip.

1. good tip
2. fair tip
3. moderate tip
4. some tip
5. a little tip
6. a few tip
7. no tip.

Colour of tip.

1. bright golden
2. golden
3. silver
4. pale
5. dull.

Colour of dry leaf.

1. black
2. red
3. brown
4. rather grey
5. grey
6. very grey.

Infused leaf.

1. Very good, bright even
2. good, bright, even
3. bright, even, not red enough.

4. bright, greenish
5. fairly good
6. fair
7. mixed
8. rather dull.
9. dull.
10. dark.

Colour of liquors.

1. very good.
2. good
3. fairly good
4. fair
5. only fair
6. poor.

Strength of liquors.

1. very good
2. good
3. fairly good
4. fair
5. only fair
6. poor.

Quality of liquors.

1. very good
2. good
3. fairly good
4. fair
5. only fair
6. poor.

Briskness of liquors.

1. pungent
2. very good
3. good
4. fairly good
5. fair
6. only fair
7. lacking in brisknes
8. soft.

It is suggested that these descriptions, modified by the suggestions of tasters, shall always be used, and that no other terms be applied when describing experimental teas from Toclai

Thus reports on teas might read :—

Tea marked A. Valuation 11-6.

A little tip : pale
Dry leaf : brown
Infused leaf : fairly good
Colour of liquor : good
Strength : good
Quality : only fair
Briskness : good.

Tea marked B. Valuation 11-0

A little tip : pale
Dry leaf : brown
Infused leaf : fairly good
Colour of liquor : good
Strength : fairly good
Quality : good
Briskness : fairly good.

It would then be clear that A had scored in strength and briskness.

Tea marked C. Valuation 11-0

A little tip : pale
Dry leaf : brown
Infused leaf : fairly good
Colour of liquor : good
Strength : fairly good
Quality : fairly good
Briskness : fairly good.

It would then be plain that B and C are valued alike because the better strength of B is considered to offset the better quality of C.

The use of agreed terms, and of such terms only, would enable comparison to be made between any one tea and any other, on a sound statistical basis.

Mr. Cooper added that there had been no reply to this circular. Mr. Nicholl asked if a copy of this circular letter could be sent to the Indian Tea Association Committee in Calcutta, and the Chief Scientific Officer promised to do this.

Mr. Graham's third point was in connection with the necessity or otherwise for withering and suggested that experiments in this connection were needed. Mr. Carpenter agreed that this was so and said that the matter would receive his consideration.

Mr. Rainey said that many concerns would be glad to have results on comparative tests of cement floors, aluminium and zinc sheetings for fermentation. Messrs. Carpenter and Benton agreed that early results should be possible.

Mr. Graham suggested that any officer of Tocklai visiting Tulsipara might be asked to give a lecture at the local club and that a conducted tour of the plots at Tulsipara would be greatly appreciated. The Chief Scientific Officer promised that information would be given when such visits were going to be made so that arrangements could be made for lectures and visits to the plots.

Mr. Cullen referred to the lighting of fermenting houses and asked whether it was necessary that fermenting houses should be kept dark. Mr. Carpenter replied that although we had no actual experiment in this connection we have reason to belive that so long as fermenting houses were cool they could be well lighted either by natural or artificial light.

In conclusion Mr. Nicholl addressed the fotlowing remarks to the Conference.

On the conclusion of this the first Conference between the senior representatives of the various districts of the Tea Industry and the staff of its Experimental Station I would like to express our thanks to Mr. Carpenter and his Officers for the trouble they have all taken to make the three days we have just spent at Tocklai so interesting.

To refer for a moment to the experiences of these three days I am sure we, the representatives of the industry, return to our respective headquarters with a much greater appreciation of the work that is being done here and that Mr. Carpenter and his officers will readily admit that they too have benefitted from the useful and friendly discussions that have taken

place. If what I have just said is correct, the direct result must therefore be a better understanding of each others' problems and difficulties. The Engledow Report remarks that while it is patently the duty of Tocklai to keep in touch with the problems of the industry it is no less incumbent on the industry to inform itself of the aims and work of its own Station, and I can, in conclusion, only say that I am sure conferences of this nature fulfil in no small measure that object.